

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

United States
Department of
Agriculture

Forest Service

Pacific
Northwest
Region

October 1987



Managing Competing and Unwanted Vegetation

Draft Environmental Impact Statement



Reserve aSB951 .4 .D7

Draft environmental impact
statement for revision

AD-33 Bookplate
(1-68)

NATIONAL

**A
G
R
I
C
U
L
T
U
R
A
L**



LIBRARY

Draft Environmental Impact Statement for Managing Competing and Unwanted Vegetation

USDA Forest Service Pacific Northwest Region States of Oregon and Washington and Portions of California and Idaho

Lead Agency: Pacific Northwest Region
USDA - Forest Service
319 SW Pine, P.O. Box 3623
Portland, Oregon 97208

Cooperating Agency: Environmental Protection Agency

Cooperating State Agencies: Agencies of the States of Oregon and Washington have cooperated in the preparation of this draft Environmental Impact Statement. Details of cooperation are presented in Appendix I.

Responsible Official: James F. Torrence,
Regional Forester
Pacific Northwest Region

For Further Information
Contact: Gary L. Larsen
Vegetation Management
Group Leader
USDA Forest Service
Pacific Northwest Region
319 SW Pine, Box 3623
Portland, OR 97208
(503) 221-2727

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY

MAR 7 1988

CATALOGING = PREP

Comments Must Be
Received By: January 15, 1988

Abstract The Forest Service, in compliance with the National Environmental Protection Act of 1969, is presenting seven alternative ways of managing competing and unwanted vegetation on the National Forests of the Pacific Northwest Region.

The alternatives are:

- A. Manage competing and unwanted vegetation without chemical herbicides.
- B. All tools are available to manage vegetation.
- C. No vegetation management.
- D. Manage vegetation by prevention and integrating natural ecosystem processes; herbicides are a last option.
- E. Aerial application and specific herbicides are prohibited, and worker safety requirements are emphasized in managing vegetation.
- F. Manage vegetation without the use of prescribed fire to treat logging slash.
- G. Manage vegetation aggressively to maximize production of resources for human use.

Alternatives B, D, and E are the Forest Service's Preferred Alternatives

The effects of the alternatives on the physical and biological environment, on human health, on social and economic conditions, and on resource management are presented.

Comments must be received by **January 15, 1988**.

Note to Reviewers

To enable the Forest Service to fully analyze and use all information acquired during the review of the draft environmental impact statement (DEIS), reviewers need to provide their comments on the draft during the established review period.

A precedent established in court obliges reviewers participating in the National Environmental Policy Act (NEPA) process to alert the agency to their positions and contentions in a meaningful way. Also important to those participating in the review is another legal precedent which established that environmental objections that could have been raised at the draft stage may be waived if they are not raised until after completion of the final environmental impact statement (FEIS).

Thus, to address all concerns, comments on the DEIS should be timely, thorough, and specific. To be most helpful, comments should address the adequacy of the statement or the merits of the alternatives discussed.

Table of Contents

Summary	Summary-1
---------------	-----------

Chapter I Purpose and Need

Managing Competing and Unwanted Vegetation	I- 1
The Forest Service Pacific Northwest Region	I- 2
<i>How This EIS Is Organized (Figure I-1)</i>	I- 3
History	I- 4
Scope	I- 5
Issues	I- 6
Human Health	I- 7
Public Participation	I- 8
Social and Economic Effects	I- 9
Costs and Benefits	I-10
Effectiveness of Techniques	I-11
Environmental Effects	I-12
Interagency Coordination	I-13
"The NEPA Process"	I-14
<i>Environmental Analysis, Documentation, and Implementation of "The NEPA Process" (Figure I-2)</i>	I-16
Future Steps for This EIS	I-17
Ties to Forest Plans	I-17
Major Legislation Relating to This EIS	I-19
Summary	I-19

Chapter II The Alternatives

How This Chapter Is Organized	II- 1
<i>How This Chapter Is Organized (Figure II-1)</i>	II- 2

Description of the Alternatives	II- 3
<i>Overview of the Alternatives (Figure II-2)</i>	II- 4
Alternative A	II- 6
Alternative B	II- 8
Alternative C	II-10
Alternative D	II-12
Alternative E	II-14
Alternative F	II-16
Alternative G	II-18
The Preferred Alternatives	II-20
Comparing the Alternatives	II-21
<i>How Alternatives Respond to Issues (Figure II-3)</i>	II-22
Comparing the Human Health Dimension of the Alternatives	II-24
<i>Acres Treated (Table II-1)</i>	II-24
<i>Anticipated Number of Worker Accidents Per Year (Table II-2)</i>	II-25
<i>Comparing Risk Indices from Exposure to Herbicides and Smoke (Table II-3)</i>	II-26
<i>Worker Accident Risk Compared to Alternative C (Figure II-4)</i>	II-27
<i>Comparison Index for Risks From Exposure to Herbicides and Fire Smoke (Figure II-5)</i>	II-27
Comparing the Public Participation Dimensions of the Alternatives	II-28
Comparing the Social and Economic Dimensions of the Alternatives	II-29
<i>Changes in Jobs in Oregon and Washington by Alternative (Table II-4)</i>	II-29
<i>Changes in Personal Income in Oregon and Washington by Alternative (Table II-5)</i>	II-30
<i>Changes in Average Annual Payments to Local Governments Table II-6)</i>	II-30
Comparing the Cost/Benefit Dimension of the Alternatives	II-31
<i>Change in Economic Efficiency by Alternative (4 percent discount rate) (Table II-7)</i>	II-33
<i>Change in Economic Efficiency by Alternative (7-1/8 percent discount rate) (Table II-8)</i>	II-35
<i>Estimated Change in Annual Forest Service Budgets (Table II-9)</i>	II-35
Comparing the Environmental Effects Dimension of the Alternatives	II-36
<i>Acres Treated Using Methods Having Potential Impacts on Physical and Biological Resources (Table II-10)</i>	II-37

<i>Average Annual Production of Suspended Particulates Less Than 2.5 Microns in Diameter Produced by Prescribed Fire (Table II-11)</i>	II-37
<i>Expected Average Number of Acres Burned Annually by Wildfire (in the fifth decade) (Table II-12)</i>	II-38
Comparing the Effectiveness of Techniques Dimension of the Alternatives	II-41
<i>Relative Effectiveness of Vegetation Management (Table II-13)</i>	II-41
Comparison of the Interagency Coordination Dimension of the Alternatives	II-45
Alternatives Considered but Eliminated From Detailed Study	II-47
Implementing the Alternatives	II-51
<i>"Five Steps" in Managing Competing and Unwanted Vegetation (Figure II-6)</i>	II-52
<i>How the Five Step Vegetation Management Process Fits Within Environmental Analysis (Figure II-7)</i>	II-53
The Five Steps in Managing Unwanted and Competing Vegetation	II-54
Step One: Site Analysis	II-54
Step Two: Select Strategy	II-55
<i>Illustrating Strategies and Thresholds in Managing Competing Vegetation (Figure II-8; Figure II-9)</i>	II-56
Step Three: Design Project	II-58
Step Four: Action	II-60
Step Five: Monitoring	II-60
Mitigation Measures and Vegetation Management Methods	II-63
Mitigation Measures Common to All Methods and All Alternatives	II-64
Biological Methods	II-67
Biological Mitigation Measures	II-70
Prescribed Burning Methods	II-70
Prescribed Burning Mitigation Measures	II-73
Manual Methods	II-75
Manual Mitigation Measures	II-76
Mechanical Methods	II-76
Mechanical Mitigation Measures	II-78
Herbicide Methods	II-78
<i>Frequency of Herbicide Use by Activity and Application Method (Table II-14)</i>	II-80

Herbicide Mitigation Measures	II-81
<i>Activity and Implications by Alternative (Figure II-10)</i>	II-86

Chapter III

Affected Environment

Location and Setting	III- 1
<i>National Forests of the Pacific Northwest Region (Figure III-1)</i>	III- 2
<i>Geographic Features of Oregon and Washington (Figure III-2)</i>	III- 3
<i>Geographic Subregions of the Forests (Table III-1)</i>	III- 4
Geology	III- 4
Climate	III- 5
Soils	III- 6
Fire	III- 7
Air	III-11
<i>Class I Areas in Oregon and Washington (Table III-2)</i>	III-14
<i>Class I Areas of the Pacific Northwest (Figure III-3)</i>	III-15
<i>Designated Areas in Oregon and Washington (Figure III-4)</i>	III-17
<i>Oregon Proportion of Particulate From Forestry Burning (Figure III-5)</i>	III-19
Water	III-20
Vegetation	III-22
Forests	III-25
<i>Timber Productivity on Available Commercial Forest Lands in the Pacific Northwest Region (Table III-3)</i>	III-26
<i>Standing Softwood Volumes on Commercial Forest Lands of the Pacific Northwest Region (Table III-4)</i>	III-27
Range Ecosystems	III-28
Riparian Vegetation	III-29
Noxious Weeds	III-30
Diversity	III-31
Threatened, Endangered, and Sensitive Plant Species	III-33
Wildlife and Wildlife Habitat	III-34
Threatened, Endangered, and Sensitive Animal Species	III-36

<i>Threatened and Endangered Wildlife Species (Table III-5)</i>	III-36
Fisheries	III-37
Insects and Disease	III-38
Land Uses	III-39
Recreation	III-40
Facilities	III-41
Rights-of-Way Maintenance	III-42
Scenery	III-44
Cultural Resources	III-45
Public Health	III-46
Herbicide Use	III-46
<i>Forest Service Herbicide Use Before 1982, Pacific Northwest (Table III-6)</i>	III-47
<i>Average Numbers of Workers for Herbicide Application Activities, By Type of Application (Table III-7)</i>	III-48
Social and Economic Conditions	III-48
<i>Population Size and Growth Rates, Oregon and Washington (Table III-8)</i>	III-50
<i>Population Distribution—Urban and Rural, 1980 (Table III-9)</i>	III-51
<i>Employment in Oregon and Washington in the Mid-1980's (Table III-10)</i>	III-52

Chapter IV

Environmental Consequences

Background	IV- 1
Incomplete or Unavailable Information	IV- 6
<i>Incomplete or Unavailable Information (Figure IV-1)</i>	IV- 8
Geology	IV- 13
Climate	IV- 13
Soil Resources	IV- 13
<i>Acres Manually Treated Each Year (Table IV-1)</i>	IV- 14
<i>Miles Manually Treated Each Year (Table IV-2)</i>	IV- 14
<i>Acres Mechanically Treated Each Year (Table IV-3)</i>	IV- 14

<i>Acres Thermally Treated Each Year (Table IV-4)</i>	IV- 16
<i>Acres Grazed Annually (Table IV-5)</i>	IV- 19
<i>Acres Treated With Herbicides Each Year (Table IV-6)</i>	IV- 19
<i>Acres Treated With Herbicides for Road Maintenance Each Year (Table IV-7)</i>	IV- 19
<i>Acres Treated Each Year Using Methods With Possible Impacts on the Soil Resource (Table IV-8)</i>	IV- 22
<i>Recommended Concentration Maximums for Silvicultural Chemicals by Stream Class and User Group (Table IV-9)</i>	IV- 25
<i>Comparison of Herbicides (Table IV-10)</i>	IV- 26
<i>Fire</i>	IV- 28
<i>Expected Area Burned in the First and Fifth Decades by Alternative (Table IV-11)</i>	IV- 29
<i>Expected Acres Burned by Wildfire/Pacific Northwest Region (Figure IV-2)</i>	IV- 30
<i>Expected Acres Burned by Wildfire/East-side (Figure IV-3)</i>	IV- 30
<i>Expected Acres Burned by Wildfire/West-side (Figure IV-4)</i>	IV- 31
<i>Area of Prescribed Burn by Subregion (Figure IV-5)</i>	IV- 33
<i>Biomass Consumed per Acre by Subregion (Figure IV-6)</i>	IV- 34
<i>Fine Particulate (PM 2.5) Emissions, by Alternative, Western Oregon (Figure IV-7)</i>	IV- 35
<i>Fine Particulate (PM 2.5) Emissions, by Alternative, Eastern Oregon (Figure IV-8)</i>	IV- 35
<i>Fine Particulate (PM 2.5) Emissions, by Alternative, Western Washington (Figure IV-9)</i>	IV- 36
<i>Fine Particulate (PM 2.5) Emissions, by Alternative, Eastern Washington (Figure IV-10)</i>	IV- 36
<i>Wildfire and Prescribe Fire: Expected Area Burned Per Year (Table IV-12)</i>	IV- 37
<i>Water Resources</i>	IV- 41
<i>Maximum Concentrations of Herbicides Reported Under Conditions Found in the Pacific Northwest (Table IV-13)</i>	IV- 47
<i>Timber Yields</i>	IV- 51
<i>Potential Change in Long-Term Sustained Timber Yield (Table IV-14)</i>	IV- 58
<i>Rangeland Vegetation</i>	IV- 59
<i>Noxious Weeds</i>	IV- 60
<i>Diversity</i>	IV- 60
<i>Threatened, Endangered, and Sensitive Plant Species</i>	IV- 62

Wildlife and Wildlife Habitat	IV- 63
Threatened, Endangered, and Sensitive Animal Species	IV- 71
Riparian Resources and Fisheries	IV- 71
Specific Lands and Areas	IV- 75
Insect and Disease Conditions	IV- 76
Land Uses	IV- 76
Recreation	IV- 77
Facilities	IV- 78
Rights-of-Way	IV- 78
Road Maintenance Cost by Alternative (Table IV-15)	IV- 80
Scenery	IV- 81
Cultural Resources	IV- 82
Energy Consumption and Production	IV- 83
Human Health Effects	IV- 85
Characterization of Risk for 16 Herbicides	IV- 85
<i>Application Rates for Realistic and Worst Case Assessments</i> (Table IV-16)	IV- 89
<i>Estimated Exposures From One-Day Application (Table IV-17)</i>	IV- 90
<i>Degree of Confidence in Risk Evaluation Data (Table IV-18)</i>	IV- 94
<i>Summary of Toxic Effects for 16 Herbicides, General Toxicity</i> (Table IV-19)	IV-101
<i>Summary of Toxic Effects for 16 Herbicides, Reproductive Effects</i> <i>and Developmental Effects (Table IV-20)</i>	IV-102
<i>Summary of Toxic Effects for 16 Herbicides, Neurotoxicity and</i> <i>Immunotoxicity (Table IV-21)</i>	IV-103
<i>Summary of Toxic Effects for 16 Herbicides, Mutagenicity and</i> <i>Animal Carcinogenicity (Table IV-22)</i>	IV-104
<i>Quality of Information on 16 Herbicides by Type of Toxicity</i> (Table IV-23)	IV-105
<i>Estimated Level of Confidence That No Adverse Human Health Effects</i> <i>Will Occur, (Public Exposure, Aerial Spraying) (Table IV-24)</i>	IV-106
<i>Estimated Level of Confidence That No Adverse Human Health Effects</i> <i>Will Occur (Worker Exposure, Backpack Spraying) (Table IV-25)</i>	IV-107
<i>Estimated Level of Confidence That No Adverse Human Health Effects</i> <i>Will Occur (Public Exposure, Accidental Spraying) (Table IV-26)</i>	IV-108
<i>Comparison of Cancer Hazards for 16 Herbicides (Table IV-27)</i>	IV-109
Types of Human Health Effects	IV-118

Comparison of Human Health Risks Associated With Various Methods of Vegetation Management	IV-119
<i>Oregon 1985 Fire Emissions Estimates (Table IV-28)</i>	IV-121
Comparison of Risk Among Alternatives	IV-125
<i>Thousands of Acres Treated Yearly by Method and Alternative (Table IV-29)</i>	IV-125
Costs and Benefits	IV-129
National Forest Budgets	IV-129
Social and Economic Effects	IV-129
<i>Changes in Numbers of Jobs in Oregon and Washington (Table IV-30)</i>	IV-131
<i>Changes in Average Annual Personal Income in Oregon and Washington (Table IV-31)</i>	IV-131
<i>Changes in Annual Payments to Local Governments (Table IV-31)</i>	IV-132
Short-Term Use Versus Long-Term Productivity	IV-133
Unavoidable Adverse Effects	IV-134
<i>Index for Risks To Workers and the Public for Exposures to Herbicides and Fire Smoke (Figure IV-11)</i>	IV-135
<i>Comparison of Benefits to Public Risk From Exposure to Herbicides and Fire Smoke (Figure IV-12)</i>	IV-136
<i>Comparison of Worker Injuries to Public Risk From Exposure to Herbicides and Fire Smoke (Figure IV-13)</i>	IV-137
Irreversible and Irretrievable Commitments of Resources	IV-139

List of Preparers

List of Agencies, Organizations, and Individuals to Whom Copies of the Statement Were Sent

References

Glossary

Index

Appendices

- Appendix A** Timber Growth and Yield Analysis
- Appendix B** Economic Efficiency Analysis
- Appendix C** Herbicide Use and Efficacy
- Appendix D** Human Health Risk Assessment (Quantitative)
- Appendix E** Silviculture Program Effects
- Appendix F** Rangelands of the Pacific Northwest Region
- Appendix G** Resource Programs and Vegetation Management Activities
- Appendix H** Human Health Risk Assessment (Qualitative)
- Appendix I** Public Participation and Consultation

Summary

Summary

The Pacific Northwest Region of the USDA Forest Service is headquartered in Portland, Oregon. It includes Oregon, Washington, and parts of a few counties in California and Idaho. In this Region, the Forest Service administers 19 National Forests (including one National Grassland) totalling 24.5 million acres.

Terrain and vegetation vary widely across the Region. There is a great variety of landforms, from coastal dunes and flat grasslands to rolling hills, steep ridges, and volcanoes. Natural vegetation ranges from the Olympic rain forest to interior high deserts.

In the course of managing National Forests in the Pacific Northwest, managing competing and unwanted vegetation is a major effort. The effort involves many activities, such as preparing sites for planting trees, or clearing away roadside brush. Each activity uses different methods to treat the vegetation, including burning with prescribed fire, cutting by hand, crushing with heavy equipment, or spraying with herbicides.

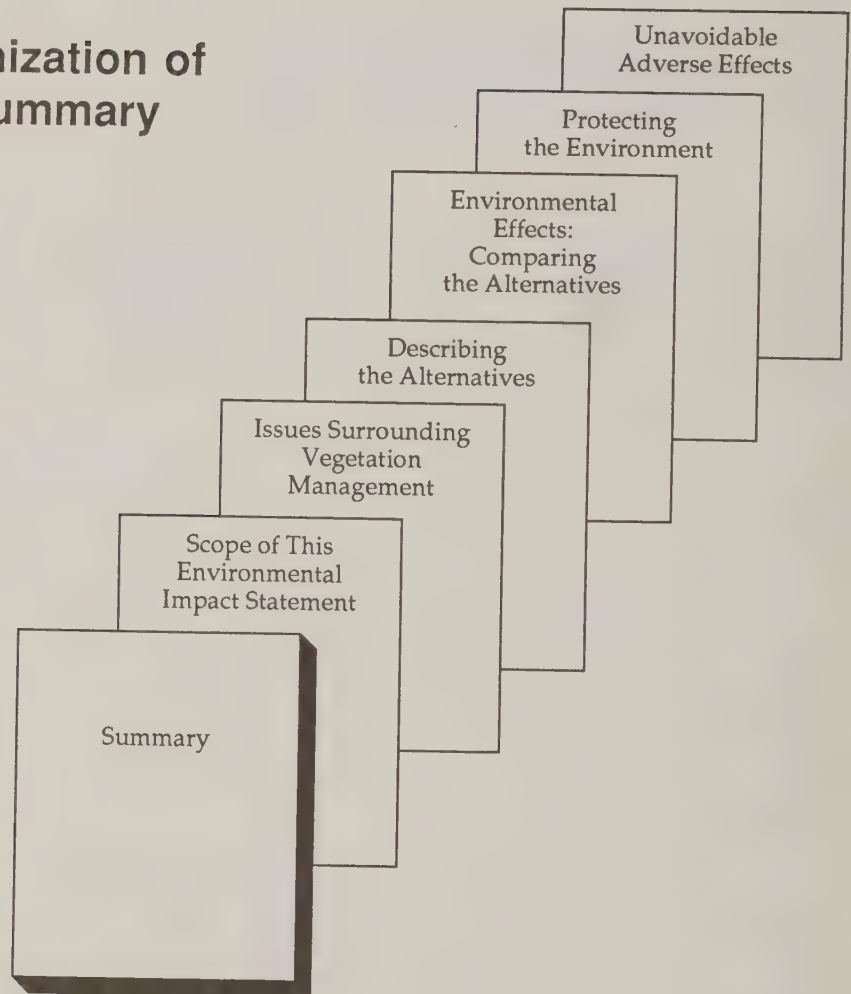
This large program has the potential for significant environmental effects, and has generated public concern and a series of issues. A Draft Environmental Impact Statement has been prepared. This is a summary of that document. It outlines the Region's vegetation management program, its issues, the proposed alternatives and mitigation measures, and the environmental effects of those alternatives.

After carefully considering comments from the public, scientists, and government agencies on the Draft Environmental Impact Statement (DEIS), a Final Environmental Impact Statement (FEIS) will be prepared and issued. That final version will be the basis for the selection of a new program of vegetation management.

Decisions based on the Final Environmental Impact Statement could affect future Forest Plans. Both existing plans and those being prepared assume that all methods of managing competing and unwanted vegetation are available. If the new vegetation management program would significantly change the way lands and resources would be managed on a National Forest, then changes in the Forest Plan will be made as needed.

Information is arranged in this summary as shown:

Figure S-1
**Organization of
 the Summary**



Scope of This Draft Environmental Impact Statement

At the end of the environmental analysis process documented in both the Draft and Final Environmental Impact Statements, the Regional Forester will select a program for managing vegetation. This program affects all Forest Service activities requiring the management of competing and unwanted vegetation, including logging residue (slash). These activities include:

- preparing sites for planting trees;
- releasing young conifers from competing vegetation;
- managing and preventing fires;
- improving range conditions for livestock;
- controlling noxious weeds;
- improving wildlife habitat;
- maintaining recreation and administrative facilities;
- maintaining roadsides and utility corridors; and
- supporting the tree genetics and research programs.

Many of the items listed are major activities involving a variety of actions and tasks. Only the portions of each activity that involve managing competing and unwanted vegetation are affected by decisions made as a result of this Draft Environmental Impact Statement. (Note: activities in Forest Service tree nurseries are not included; they will be analyzed separately in a different environmental impact statement.)

Methods of vegetation management considered here include use of herbicides, prescribed burning, manual work, biological treatments, and mechanical means.

Managing Competing and Unwanted Vegetation

Unwanted plants and residues are part of ecological systems. They may play useful as well as harmful roles in those systems. Thus, an understanding of each ecological system is essential for effective management of unwanted vegetation, and is also necessary for long-term beneficial use of those plant communities.

Efforts to control or eradicate unwanted vegetation may have significant environmental impacts on the rest of the ecological system. An environmental impact statement such as this one examines those environmental impacts.

In an environmental analysis, public issues play a substantial role in forming the alternatives, raising questions for analysis, and focusing thought and discussion when selecting the preferred alternatives.

The following issues were distilled from the comments of the general public, interested groups, government agencies, and Forest Service employees. These people participated in early public involvement efforts that provided information about issues this environmental impact statement should address, and about ways the public could be involved throughout the whole analytical process.

The seven public issues shaping this Draft Environmental Impact Statement are:

Human Health

Human health issues have been a major focus of controversy over vegetation management practices in recent years. Much attention has centered on the safety of using herbicides for vegetation control. The effects of smoke from prescribed burning has also emerged as an important health issue, along with the need to evaluate the health and safety effects of manual methods of managing vegetation.

Public Participation

Public participation is an element of a successful program for manag-

Issues Surrounding Vegetation Management

ing public lands and natural resources. Public participation in vegetation management decisionmaking is an especially important and sensitive issue because of past conflict-charged relations. Members of the public have asked to be included throughout the development of the Draft Environmental Impact Statement; for continuing participation and information sharing after the decision has been made; for participation in site-specific, project level planning; and for readable, clear analyses and documents.

Social and Economic Effects

Vegetation management activities have direct effects on employment and the quality of community life. The vegetation management program influences how much timber the Region can grow and harvest. The quality of grazing, water, recreation, and wildlife habitat may also be affected. These Forest activities support jobs directly and indirectly in many sectors of the economy. The alternatives will have economic effects, along with effects on the well-being of communities.

Cost and Benefit Analysis

National Forests offer a wide range of goods and services. Some of those goods and services are sold or leased; other are provided at no fee. It also takes money, people, and resources to manage the Forests. The concern in this issue is that money and resources be wisely managed and put to the most effective and most beneficial use.

Environmental Effects

All facets of the environment contribute to providing products such as quality air, water, and timber. To produce a continuing supply of these and other benefits, the ecosystem must remain healthy. There is concern both by the public and the Forest Service about the physical and biological effects on the environment when applying vegetation management techniques.

Effectiveness of Techniques

There are many different vegetation management techniques and many different site characteristics and conditions. It is important to match the appropriate technique to the circumstance and particular site. Sharing knowledge of current techniques, products, and technology is an important aspect of this match. In addition, measures must be taken to assure that desired results are being achieved.

Interagency Coordination

Agencies at all levels of government have a shared interest in vegetation management. Many agencies have responsibilities for vegetation

management that overlap those of the Forest Service. These may be directly or indirectly affected by decisions made as the result of an environmental analysis. Coordination with national, state, and local agencies is important in developing a program for vegetation management.

In an environmental impact statement, the alternatives propose alternate direction for the activities being considered. The different effects of the alternatives, including their advantages and disadvantages, can be compared and evaluated. This Draft Environmental Impact Statement provides seven alternative ways of managing competing and unwanted vegetation.

The seven alternatives provide different instructions to the people analyzing, designing, and carrying out vegetation management in the Region. Thus, rather than specifying the precise way a particular project would be done, these alternatives present different ways that the vegetation management program would be conducted across the whole Region.

While the alternatives differ in the kind and degree of instruction given, all require a site-specific analysis covering each project to be conducted by the local National Forest or Ranger District. Analysis procedures are firmly guided by "the NEPA process"—the Forest Service procedures for implementing the National Environmental Policy Act.

Describing the Alternatives

Figure S-2

Overview of the Alternatives

Alternatives	A	B**	C
Manages Competing and Unwanted Vegetation	...with no herbicides.	...with all effective tools.	...rarely, and only for human safety.
Time for Action	At first sign before damage occurs.	At first sign before damage occurs.	No action unless vegetation threatens public safety.
Project Design	Prevention* and correction* both o.k.; herbicides will not be used.	Prevention and correction both o.k.; all tools and methods available.	Correction only; fire and herbicides both prohibited.

* "Prevention" and "correction" are two strategies for managing vegetation.

Successful prevention keeps vegetation problems from getting to the point where they require correction.

** Forest Service preferred alternatives.

D****E******F****G**

...emphasizing prevention and the use of natural processes.

...with restricted use of herbicides and special worker safety.

...with no burning for silviculture.

...aggressively, with all tools.

At first clear sign of potentially significant damage.

At first sign, before significant damage occurs.

At first sign, before damage occurs.

At first sign, before damage occurs.

Prevention is preferred; herbicides available as a last option.

Prevention is preferred; some herbicides prohibited, no aerial application; manual use restricted.

Prevention and correction o.k.; fire will not be used to treat slash or prepare planting sites.

Prevention and correction o.k.; all tools and methods freely available.

The Alternatives ***Alternative A***

This alternative is designed to eliminate all risk associated with the use of herbicides. Other effective and efficient techniques are to be used in managing competing and unwanted vegetation.

In compliance with a 1984 U.S. District Court injunction, the Forest Service in the Pacific Northwest currently cannot use herbicides. Alternative A approximates this current vegetation management program carried into the future.

Alternative B

Under Alternative B, all effective and efficient techniques for managing competing and unwanted vegetation are available, consistent with the direction provided in applicable land and resource management plans.

The management of competing and unwanted vegetation specified in this alternative approximates the direction presented in proposed Forest Plans. Alternative B and the fiscal year 1989 program serves as the reference for comparison of budgets, outputs, and vegetation management activities for all other alternatives.

Alternative C

The vegetation management approach here is one of "no action" unless public safety is clearly and directly threatened. For example, hazard trees will be removed from campgrounds, and roadside brushing will be done to maintain safe travel, but virtually none of the vegetation management normally associated with forest management will be done. Some resource production objectives may not be met.

There is virtually no active intervention to manage competing and unwanted vegetation in Alternative C. Only situations that pose a direct threat to public safety will trigger action to suppress unwanted vegetation. In these cases, neither herbicides nor fire will be used.

Alternative D

The key to this alternative is the prevention of problem vegetation conditions through the integration of natural ecosystem processes into management of competing and unwanted vegetation. In Alternative D, vegetation management emphasizes leaving the least impact on the natural environment while producing products and amenities for human use.

The implementation of this alternative will involve early preventive measures, monitoring of sites, and frequent evaluations of conditions and practices. Vegetation is managed to avoid the need for corrective measures. However, correction, if needed, is done in a way to least alter natural ecosystems and processes.

Alternative E

This alternative is designed to reduce the risks of herbicide use to the public, and to improve the safety of forest workers when they apply herbicides and cut vegetation. No aerial application of herbicides is permitted; specific herbicides are prohibited; and additional safety requirements for workers are imposed.

Alternative F

This alternative is designed to manage competing and unwanted vegetation without the use of prescribed fire for silvicultural purposes. All other effective and efficient techniques of vegetation management are available. The burning of logging slash will be allowed for reducing wildfire hazards. Residue utilization is encouraged in place of burning; and burning of chemically treated vegetation is prohibited.

Alternative G

This alternative manages competing and unwanted vegetation more aggressively than Alternative B. The emphasis is on maximum production of forest resources for human use. All cost-efficient techniques for managing vegetation are available. It stresses looking for opportunities to increase timber and forage production (through vegetation management) beyond that predicted by the Forest Plans.

Preferred Alternatives

Alternatives B, D, and E are the Forest Service's preferred alternatives. The three alternatives are especially responsive to the key issues of human health, social and economic effects, and effects on the environment. In the Final Environmental Impact Statement, one alternative will be selected as the preferred alternative, and it will be the basis for the Region's vegetation management program in the future.

Chapter IV in the Draft Environmental Impact Statement presents in detail the environmental consequences of the alternatives. For this Summary, much-condensed presentations of the information are found in Figures S-3 and S-4.

This Draft Environmental Impact Statement examines alternative programs for managing competing and unwanted vegetation. It is concerned with how a series of vegetation management programs—conducted over a period of years—could affect the environment and the production of goods and services from the Region's National Forests.

Effects were analyzed for a great range of resources—from soil and water to timber, recreation, wildlife, and social and economic conditions. The public issues say that several environmental effects are

**Environmental
Effects:
Comparing the
Alternatives**

Figure S-3

Activity and Implications by Alternative

	A	B
Acres managed annually for competing and unwanted vegetation:		
Total	552,100	553,000
Using herbicides	0	59,900
Using mechanical methods	184,600	167,200
Using manual methods	99,000	77,800
Using biological methods	14,800	4,300
Using prescribed fire	217,800	210,000
Receiving no treatment	24,400	19,900
Other	11,500	14,100
Annual Effects and Implications:		
Risk to Workers (Index) ¹	266	318
Risk to Public (Index) ¹	266	288
Risk to Workers (Injury accidents)	1,260	1,082
Emissions from Prescribed Fires (Change from current):		
West-side	36% less	33% less
East-side	33% less	35% less
Long-Term Sustained Yield Capacity²: (Change from Alternative B, in million board feet)	95 to 125 less	0
Present Net Value³: (Change from Alternative B, in million dollars)	468 less	0
Change in Jobs⁴: (Change from Alternative B)	1,100 fewer	0

¹The risk index (higher values indicate higher risk) is a function of the areas treated with herbicides, with prescribed fire, and subject to wildfire.

²This is the long-term capacity for the entire Pacific Northwest Region; the percent change will be greater for some National Forests, less for others. The allowable timber sale quantity will be set by Forest Plans. The tie between it and long-term capacity varies by National Forest.

³Present Net Value is a measure of all the benefits from the National Forests that can be expressed in dollars after the costs of managing the Forests have been subtracted. Future costs and benefits are discounted at four percent.

⁴The change in the number of jobs includes all jobs directly and indirectly affected jobs in Oregon and Washington.

Summary

Comparing the Alternatives

C	D	E	F	G
86,800	380,500	548,600	566,400	579,600
0	26,800	47,900	64,100	76,600
44,900	111,600	166,900	201,000	155,600
17,700	57,800	95,100	80,100	85,700
3,800	18,700	5,900	8,300	6,900
0	125,800	194,000	175,800	215,000
15,600	23,800	24,100	36,100	21,500
4,800	16,000	14,700	11,000	18,300
75	216	290	294	343
75	203	242	262	305
192	760	1,179	1,029	1,156
no burning for veg. management	63% less 60% less	46% less 37% less	63% less 53% less	35% less 31% less
1,000-2,000 less	55-85 less	35-65 less	95-125 less	95-125 more
3,877 less	246 less	132 less	322 less	24 more
21,700 fewer	3,100 fewer	1,300 fewer	3,100 fewer	2,600 more

Figure S-4

How Alternatives Respond to Issues

ISSUES	UNIT OF MEASURE	ALTERNATIVE	
		A	B
Human Health	Qualitative risk assessment	Eliminates risk from herbicides. Increased risk from other methods. Reduces perceived risk by public.	Historical risk pattern continues. Problems with perceived risk continue.
Public Participation	Guidelines for project planning	Same as Alternative B.	Interested public informed and involved in vegetation management.
Social & Economic Effects			
- Change in payments to local governments	Million \$ per year	- 4.9	Reference***
- Change in personal income	Million \$ per year	- 28	Reference
- Change in jobs	Number of jobs	- 1,100	Reference
- Predicted change in LTSYC* capacity (over full rotation)	% Change Million Board Feet	- 2-1/2 to 3% - (95 to 125)	Reference
Cost/Benefit Analysis			
- Change in Present Net Value	Million \$	- 468	Reference
- Change in Forest Service Budget	Million \$	+ 1	Reference
Environmental Effects			
- Long-term productivity	Biomass Production	Same as Alternative B.	Continuation of current conditions, as modified by applicable land and resource management plans.
- Air quality (All alternatives meet state TSP** reduction goals by the year 2000.)	Reduction of TSP emissions from current levels by the year 2000	West-side levels reduced by 36%; East-side levels reduced by 35%.	West-side levels reduced by 33%; East-side levels reduced by 35%.
Effectiveness of Techniques	Quality of tree establishment and early growth (Commercial species)	Some problems in tanoak-madrone, ceanothus spp. and herbaceous veg., leading to tree mortality and growth loss in new plantations.	Continuation of current techniques (with herbicides restored to use).
Interagency Coordination	Guidelines for project planning	Same as Alternative B.	Coordination with State and local agencies required in project design.

* LTSYC: Long-Term Sustained Yield Capacity (for timber production). This is the average for all 19 National Forests. The change will be much greater on some forests; less on others. The annual timber sale quantity will be determined in individual Forest Plans.

**TSP: Total Suspended Particulates (smoke).

*** Reference: Level expected with implementation of the Forest Plan.

C	D	E	F	G
Little risk from managing vegetation. Some increased risk from noxious weeds and travel accidents.	Risk decreases through prevention. Because of less treatment, perceived risks lowered.	Risk to public reduced. Risks to workers near current levels, despite extra safety measures. Perceived risk lower.	Risks from fire and smoke reduced. Increase in herbicide use. Perceived risks probably higher.	Risk to public and workers increases because of more treatment. Perceived risks increased.
Involvement infrequent due to few projects.	As in Alternative B, with increased emphasis is on early involvement through to project implementation.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.
- 57.1	- 7.4	- 4.3	- 8.4	+ 2.6
- 533	- 76	- 33	- 75	+ 63
- 21,800	- 3,100	- 1,400	- 3,100	+ 2,600
- 25 to 50%	- 1-1/2 to 2%	- 1 to 1/2%	- 2-1/2 to 3%	+ 2-1/2 to 3-1/2%
- 1,000 to 2,000	- 55 to 85	- 35 to 65	- 95 to 125	+ 95 to 125
- 3,877	- 246	- 132	- 322	+ 24
- 126	- 21	- 9	- 19	+ 20
Substantial loss; fire increases above current and natural levels, results in soil damage.	Slight increase from leaving biomass on site, fire risk managed, nutrient availability will increase.	Same as Alternative B.	Same as Alternative B.	Slight decrease. Aggressive control and residue use results in less biomass, nutrients on site. Less mechanical and fire damage to soils.
No burning for silviculture; but substantial increases in wildfire and smoke.	West-side levels reduced by 63%; East-side levels by 60%.	West-side levels reduced by 46%; East-side levels reduced by 37%.	West-side levels reduced by 63%; East-side levels reduced by 53%.	West-side levels reduced by 35%; East-side levels reduced by 31%.
No vegetation management.	Minor reduction in effectiveness on some existing problem sites; future techniques will draw on experience with preventive measures, effectiveness will be near current levels.	Effectiveness reduced in dense vegetation and steep terrain.	Effectiveness reduced in plantations with large amounts of competing vegetation or logging residue.	Some marginally suitable land will come under management. Stocking levels will increase in some areas.
Little coordination, as no management of most competing and unwanted vegetation.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.

of strong concern.

Two areas of environmental effects are of particular interest to many people: human health risks, and the economic effects of variations in timber production. Concern for risks to human health are primarily related to the use of herbicides; smoke due to prescribed fires; and accidents. Concern about economic variations is related to changes in jobs; long-term yields of forests; and economic effectiveness.

Each alternative was constructed to respond with special emphasis to a different issue or combination of issues. Thus, each has its own set of environmental effects.

The analysis of environmental effects of each alternative addresses the effects of different methods of vegetation management on the physical, biological, social, and economic components of the environment.

For each management activity, the general effects of each of the five methods of vegetation management treatments (use of herbicides, prescribed fire, mechanical, manual, and biological methods) were analyzed. Mitigating measures designed to avoid adverse environmental impacts from the use of each method are also established. (The specific effects of individual projects are not assessed in this Draft Environmental Impact Statement because they will be addressed at the local level in site-specific environmental analyses.)

Chapter IV in the Draft Environmental Impact Statement presents the environmental consequences in detail. Chapter II contains a complete description of all alternatives (including those identified as “preferred”), along with a detailed comparison of them in terms of issues. Figure S-4 presents a summary of the major elements of that comparison.

Protecting the Environment

As an integral part of developing this EIS, mitigation measures were developed to reduce, avoid, or minimize potentially adverse impacts on the environment which might result from vegetation management activities.

The mitigating measures were developed using Federal laws and regulations; the intent of state resource laws; existing direction found in Forest Service Manuals and Handbooks; land and resource management plans; resource management experience; and research findings.

Several mitigating measures cover all vegetation management activities, regardless of method. Others apply to a particular method. These mitigating measures are tied to methods. If a method is used in an alternative, the mitigating measures associated with that method will be followed.

What follows is a summary of the mitigation measures that apply to vegetation management. (For more information, refer to “Mitigation Measures and Vegetation Management Methods” in Chapter II of the Draft Environmental Impact Statement. Additional information on the effectiveness and impacts of mitigation measures is in Chapter IV, Environmental Consequences.)

Mitigation Measures

Before using any method of vegetation management, Forest Service personnel will be required to:

- conduct environmental analysis, including scoping, as required in Forest Service Manual 1950, for each proposed project;
- prepare a human health risk management plan for each project; and
- provide training and quality control at Regional, National Forest, and District Offices.

The mitigation measures that apply to all silvicultural vegetation management require:

- a documented prescription, prepared or approved by a certified silviculturist; and
- a site-specific diagnosis that meets Forest Service Silvicultural Practices Handbook standards (2409.17) and treatment needs (2409.26c).

Biological methods: when using livestock to control vegetation, the Forest Service will notify affected water users, and assure strict control of livestock near riparian areas. The release of insects to control specific vegetation requires coordination with state and Federal agencies. Site analysis will explore the seeding of compatible plants and the use of genetically superior seedlings, natural seedlings, and advance regeneration as ways to prevent or minimize the need for future vegetation management.

Manual methods: when using workers with hand and power tools to treat vegetation, safety risks will be analyzed and incorporated into the human health risk management plan.

Mechanical methods: when mechanical methods of treating unwanted vegetation and logging residues are used, tractors will not be used on steep slopes; on highly compactible soils; on erodible soils in municipal watersheds; or during conditions with high risks to soils.

Buffers of vegetation will be left along streams, lakes, and wetlands to minimize sedimentation. Slash will not be piled in stream flood plains.

Use of herbicides: some of the alternatives would allow use of herbicides; some would not. If herbicides are used, there will be strict adherence to:

- EPA label instructions for the herbicide;
- applicable state and Federal laws; and
- site-specific mitigation measures.

If herbicides are used, these specific measures will be implemented:

- downstream water users and adjacent landowners will be notified of planned use of herbicides;
- precautions against accidental leaks or spills will be taken;
- mixtures will be prepared and equipment will be cleaned in areas outside sensitive watersheds, where ground water will not be contaminated;
- spray droplet size will be optimized to minimize drift;
- specified buffers will be left along streams, rivers, lakes, and wetlands;
- pilot vehicles will be used when transporting mixed herbicides; and
- monitoring will be done to assure effectiveness of mitigation measures during spray operations.

Herbicide use will be in compliance with Forest Service Pesticide Use Manual (FSM 2150) direction. Forest Service Handbook standards will be followed, specifically:

- Chapter 2109.11 for planning projects;
- Chapter 2109.12 for storing, handling, and transporting herbicides, and for spill prevention, cleanup, and disposal requirements;
- Chapter 2109.13 for defining worker training and experience requirements; and
- Chapter 6709.11 for identifying worker safety requirements.
- Individual National Forests will provide detailed guidance for large projects.
- Applicator training, testing, and licensing will be required to assure knowledge of herbicide uses, risks, and safety.
- Herbicide safety data sheets will be posted at storage facilities; in vehicles; and made available to workers.

Prescribed fire: for the use of prescribed fire, extreme care will be taken to:

- avoid excessive consumption of litter and duff;
- reduce fuel consumption on steep and erodible slopes;
- leave unburned buffers of vegetation along streams;
- protect air quality, following all state and local regulations;
- avoid intrusion of smoke into state-identified sensitive areas;
- use the best available technology to reduce smoke;
- (in Oregon) comply with Oregon State Implementation Plan prohibitions; and
- (in Washington) comply with Washington State Smoke Management Plan and Implementation Plan.

Implementation of any alternative would result in some adverse environmental effects that cannot be avoided. Standards and guidelines from Forest Plans—and mitigating measures developed in this Draft Environmental Impact Statement—are intended to keep the extent and duration of these effects within acceptable levels, but adverse effects cannot be completely eliminated.

This Draft Environmental Impact Statement examines alternative programs for managing competing and unwanted vegetation, including slash. The focus of the environmental analysis here is on how a series of projects conducted over a period of years could affect the environment.

The environmental effects of the alternatives are presented in Chapter IV of the Draft Environmental Impact Statement. The effects on the full range of environmental components and conditions are analyzed and presented. The effects on soil, wildlife, fish, timber, scenery, and other aspects are extensively portrayed. The effects of most of them vary little from one alternative to another, and these are not reported here in the Summary.

There are three areas of central concern, and these could have potentially significant adverse effects:

- human health risks;
- degradation of air quality from fires; and
- economic effects from changes in timber yields.

Unavoidable Adverse Effects

Human Health Risks

Human health risks exist for both workers and the public. Risks that workers face from vegetation management activities that were considered in the Draft Environmental Impact Statement include:

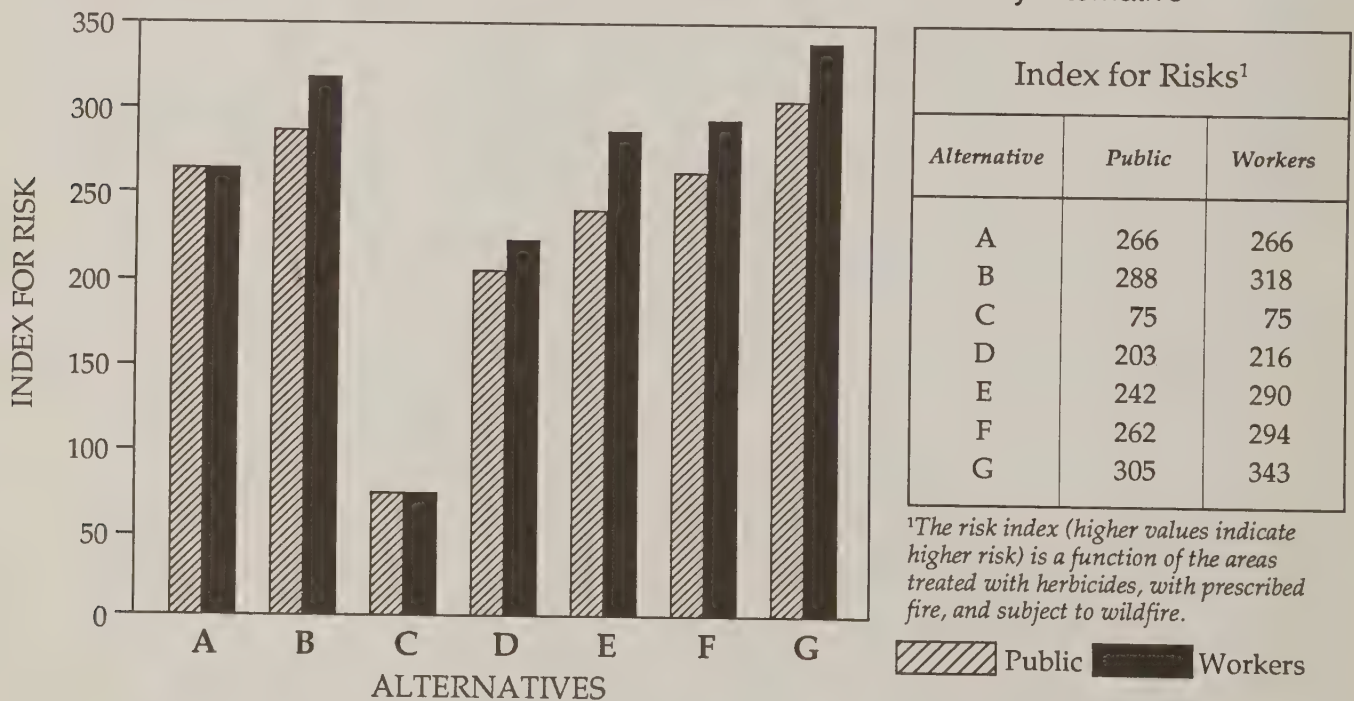
- accidents from manual control of vegetation;
- accidents from prescribed burning and wildfire suppression;
- exposure to smoke; and
- exposure to herbicides.

Two groups—forest workers and the public—face exposure to herbicides and fire smoke, (see Figure S-5). Worker exposures are far greater in quantity and duration for both herbicides and smoke, which

Figure S-5

Index for Risks

To Workers and the Public for Exposures to Herbicides and Fire Smoke by Alternative



is why these risks (as a group) are roughly equivalent to the risk to the rest of those affected (the general public). Two alternatives have significantly less risk for both groups. Alternative C has the least risk, and Alternative D has the next least risk.

Health risks to the public can come from accidental exposure to herbicides. Potential routes of exposure to herbicides are discussed in the Draft Environmental Impact Statement in detail. Greater numbers of people are exposed to smoke from prescribed fires or wildfires.

In addition to risks from herbicides and smoke, workers experi-

ence risk from accidents while using equipment and working in rough terrain. The number of predicted accidents is directly correlated with the number of acres treated by manual means and the number of acres burned.

Alternative C ("no action") has by far the fewest number of accidents related to management of competing and unwanted vegetation. Alternative D has the next fewest. All of the remaining alternatives are expected to result in considerably more accidents, with Alternatives A and E having the most (due to increased acreages treated by hand in lieu of herbicides).

Figure S-6 compares estimated yearly injuries to workers with an index for risk to the public from exposure to herbicides and fire smoke. Because risk is directly correlated to number of acres treated, as mentioned previously, risks to both the public and workers generally increase as the level of management activity increases. For Alternatives A and E, more acres are treated by hand rather than with herbicides. This change in treatment causes a decrease in public risk, and an increase in worker risk from accidents.

Air Quality

The amount of smoke produced from both prescribed fires and wildfires is estimated in the Draft Environmental Impact Statement. The section on air quality in Chapter IV displays (for each alternative) the amount of fine particulate emissions expected from use of prescribed fire.

Alternatives D and F produce significantly less suspended particulates than the rest of the alternatives, except Alternative C, which has no slash burning. (Smoke from wildfires is more dense, and the long-term risk of extensive wildfire is greatest in Alternative C.) All of the alternatives, when applied on a Regional level, meet the requirements of the Washington and Oregon State Implementation Plans, and both states' Smoke Management Plans.

Economic Effects

Vegetation management activities can affect the long-term timber yield potential of the National Forests. The Forest planning process may translate these long-term effects into present or future changes in timber yields. This, along with the effects of other factors, can affect the level of economic activity in the Region.

There are a variety of economic effects associated with each alternative. One measure is the combined change in direct and indirect jobs in the Northwest. The total employment in Oregon and Washington is approximately three million.

Figure S-6

Comparison of Worker Injuries to Public Risk From Exposure to Herbicides and Fire Smoke

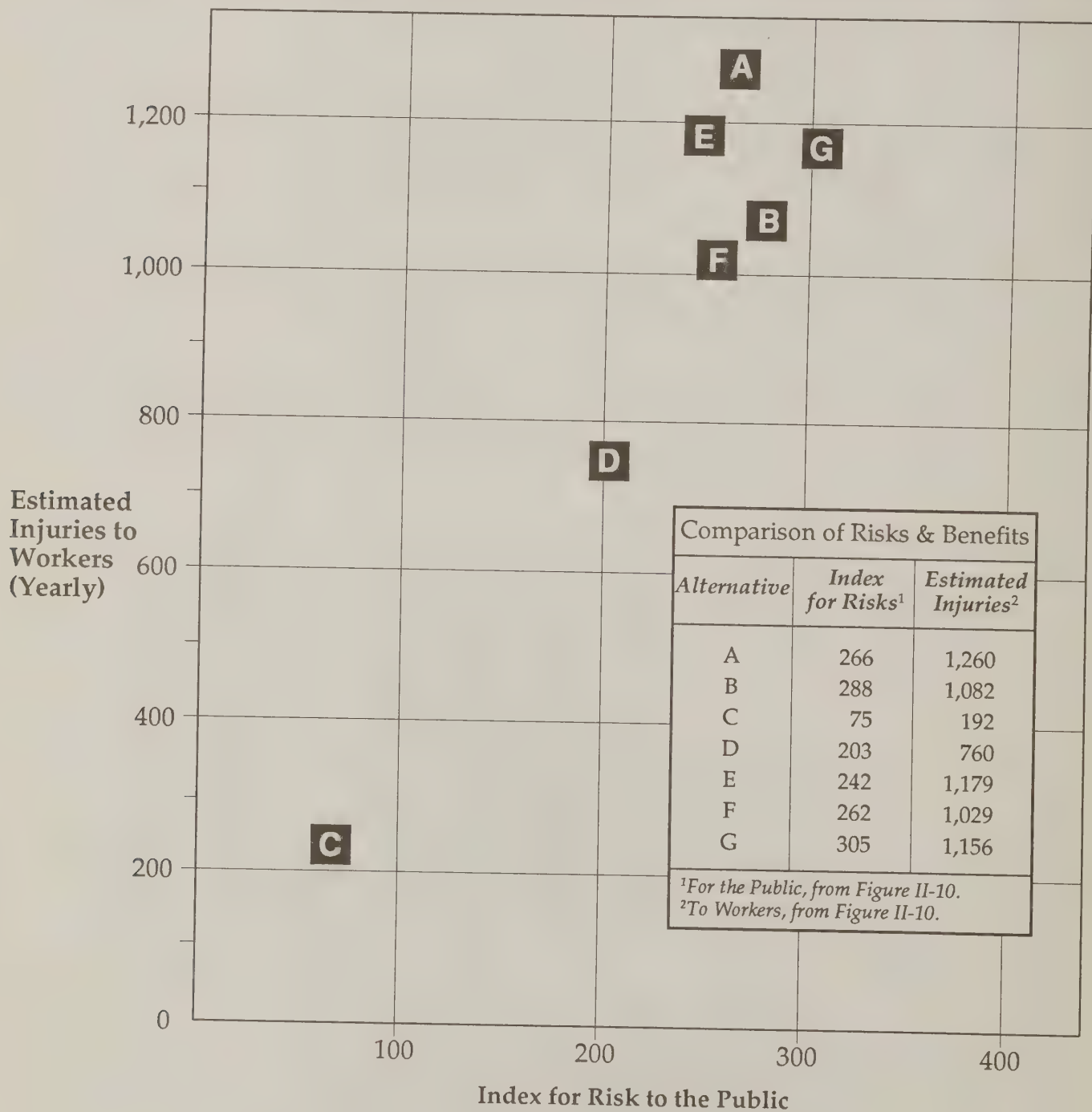
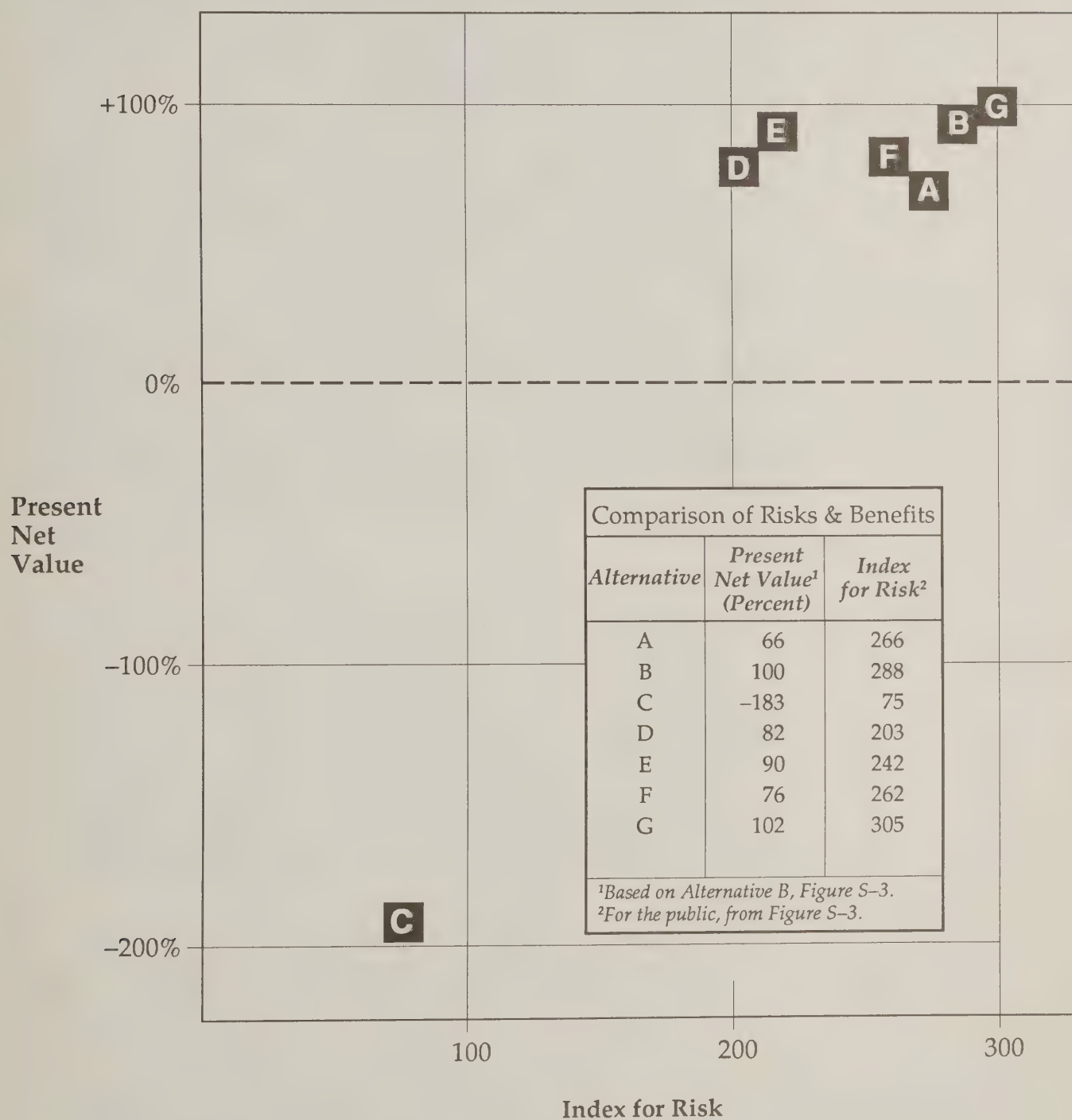


Figure S-7

Comparison of Benefits to Public Risk From Exposure to Herbicides and Fire Smoke



There are no changes in employment expected if Alternative B were to be implemented. Alternative G could increase employment by 2,600 jobs. Alternatives A and E would reduce employment by 1,100 and 1,400 jobs, respectively. Alternatives D and F would reduce employment by about 3,000 jobs. Alternative C would substantially reduce employment by about 22,000 jobs.

Activity, Risk, and Benefits

Health risks to the public at large are roughly correlated with overall level of vegetation management activity. The level of vegetation management activity also roughly correlates with levels of economic productivity.

Figure S-7 shows the relationship of risks to net dollar-measurable benefits. Alternative C has the least risk, and also has very low present net value (PNV). Alternative D has the next least risk, with much higher present net value.

Alternatives E, B, and G (respectively) yield incremental increases in present net value, for additional increments of risk. Alternatives F and A pose relatively higher risks than other alternatives with similar present net values.

Other Adverse Effects

There is the potential for additional adverse effects beyond those described above. The following effects are not expected to be significant, as standards and guidelines and mitigating measures in the Forest Plans will be in effect, as well as the mitigating measures identified in the Draft Environmental Impact Statement.

However, there is the likelihood of minor—and the potential for significant—effects when any of the alternatives which manage vegetation (all except Alternative C) are implemented. These additional adverse effects, which are usually minor, localized, and temporary, are:

- a short-term reduction in air quality from dust, smoke, and engine emissions resulting from vegetation management activities (other than prescribed burning);
- a localized reduction in long-term site productivity from burning of logging slash;
- the acceleration of natural rates of land slides and sediment by soil-disturbing activities associated with the use of heavy equipment for vegetation management projects;
- a temporary increase in fire hazard from waste material left on the ground during vegetation management activities;

- the contamination of water sources due to increased human use of the Forest;
- a decrease in habitat for wildlife species (dependent on particular plant species and growth stages) due to vegetation management activities; and
- damage to soils by compaction from heavy equipment used for vegetation management.

Again, these effects are likely to be minor and short-lived. But if mitigation measures fail, these effects could be significant on the site where they occur.

This summary of the Draft Environmental Impact Statement outlines the vegetation management program, the issues, and the proposed alternatives and mitigation measures. It also provides an overview of the environmental effects of those alternatives. Specific details of these elements are found in the Draft Environmental Impact Statement and its Appendices, available from the Regional Office (in Portland) or from the headquarters of each National Forest in the Pacific Northwest Region.

Conclusion

1. The first part of the paper discusses the importance of the study of the history of the United States. It is argued that the study of the history of the United States is essential for a full understanding of the country and its people. The paper then goes on to discuss the various methods used by historians to study the past, including the use of primary and secondary sources, and the importance of critical thinking in the study of history.

11.

2. The second part of the paper discusses the importance of the study of the history of the United States. It is argued that the study of the history of the United States is essential for a full understanding of the country and its people. The paper then goes on to discuss the various methods used by historians to study the past, including the use of primary and secondary sources, and the importance of critical thinking in the study of history.

12.

3. The third part of the paper discusses the importance of the study of the history of the United States. It is argued that the study of the history of the United States is essential for a full understanding of the country and its people. The paper then goes on to discuss the various methods used by historians to study the past, including the use of primary and secondary sources, and the importance of critical thinking in the study of history.

Chapter I

Purpose and Need

1

Chapter I

Purpose and Need

Large parts of the National Forests in Oregon and Washington are actively managed to produce timber, recreational opportunities, forage, water, wildlife habitat, and safe travel.

The forester, like the farmer and gardener, has to cope with unwanted plants ("weeds") and unwanted plant debris.

Unwanted plants compete with desired plants for sunlight, water, nutrients, and space. Other unwanted plants are poisonous to people and animals. Plants sometimes grow along roadsides and other places where they pose a hazard to travel and safety. And the plant debris left after growth or harvest may pose a fire hazard or otherwise compete with desired plants and growth.

Unwanted vegetation is part of an ecological system. It plays various roles in the system, some of which are useful to society. Forest managers recognize that an understanding of the overall ecological system is key to the effective management of unwanted vegetation.

Efforts to control vegetation could have important environmental impacts on the rest of the ecological system. An Environmental Impact Statement (EIS) examines those environmental impacts.

This Draft Environmental Impact Statement (DEIS) presents seven alternate programs for managing competing and unwanted vegetation in the National Forests of Washington and Oregon. It displays the environmental impacts and management implications of these seven alternatives.

This analysis is presented here in draft form for public review and comment. After carefully considering comments on this draft from the public, scientists, and government agencies, a Final Environmental Impact Statement (FEIS) will be prepared and issued. The Regional Forester will use the FEIS as the basis for selecting an alternative.

Managing Competing And Unwanted Vegetation

The Forest Service Pacific Northwest Region

The Pacific Northwest Region of the USDA Forest Service is headquartered in Portland, Oregon, and includes Oregon, Washington and parts of a few counties in California and Idaho. In the Pacific Northwest Region, the Forest Service administers 19 National Forests (including one National Grassland) totalling 24.5 million acres.

There are a wide variety of resource management objectives across the Region. Different sites are managed for mixes of timber production, human safety, scenic quality, livestock forage, wildlife habitat, and other objectives. Depending on the environmental conditions and the resource management goals for any specific site, some vegetation may be unwanted, or may compete with desired plants.

A plant species may be essential on one site, and unwanted on another nearby. Brushy plants compete with Douglas-fir seedlings in some parts of the Coast Range; grasses and forbs compete with conifer seedlings on the East-side. Snags provide wildlife nests in the general forest, but pose a hazard in campgrounds. Many plants provide livestock and wildlife forage and browse when they are young, but are not palatable when they mature. Plants that are valuable elsewhere may be a danger to travelers on roads when they restrict visibility and clearance. The need—or lack of need—for vegetation management activities depends on the specific objective and the specific setting.



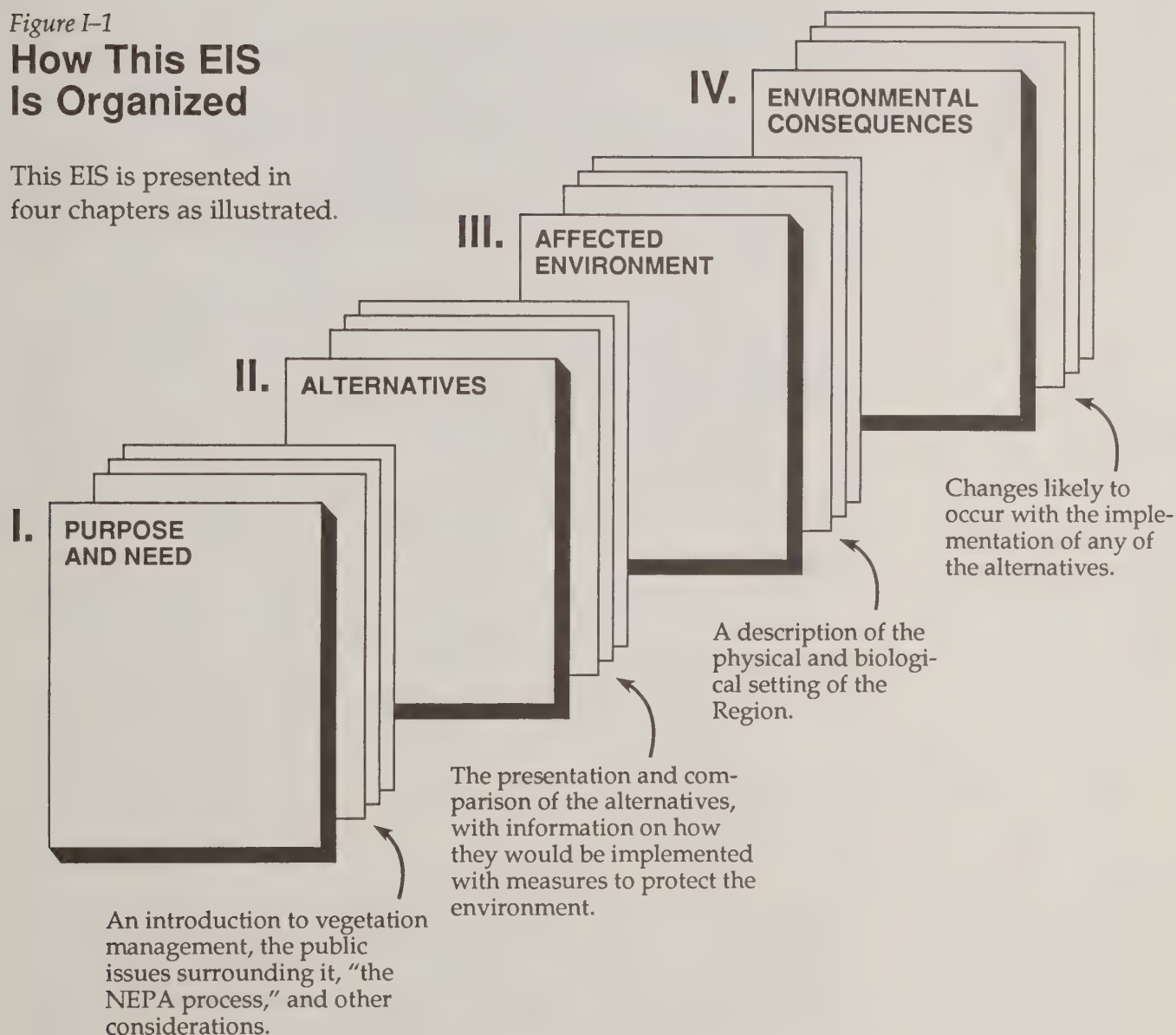
This environmental impact statement looks at how the Forest Service manages unwanted and competing vegetation in all settings. Commercial timber species are not considered unwanted or competing vegetation; thus, their management is not the direct focus of this EIS. We do, however, consider the activities related to regeneration and disposal of slash from harvest and thinning operations.

Activities requiring vegetation management are discussed in detail in Appendix G.

Figure I-1

How This EIS Is Organized

This EIS is presented in four chapters as illustrated.



Additional detailed supporting and background information is presented in appendices:

- A. Timber Growth and Yield Analysis
- B. Economic Efficiency Analysis
- C. Herbicide Use and Efficacy
- D. Human Health Risk Assessment (Quantitative)
- E. Silviculture Program Effects

- F. Rangelands of the Pacific Northwest Region
- G. Resource Programs and Vegetation Management Activities
- H. Human Health Risk Assessment (Qualitative)
- I. Public Participation and Consultation

Competing and unwanted vegetation can be managed using a range of strategies, from correction (where unwanted vegetation is controlled once it becomes a problem), to prevention (where problems—and the conditions leading to them—are anticipated and avoided). The strategies of maintenance (maintaining desired conditions by using minor actions) and of “no action” as appropriate are also useful approaches. These strategies are discussed in greater detail in Chapter II.

Terrain and vegetation vary widely across the Region. There are a great variety of landforms, from coastal dunes and flat grasslands to rolling hills, steep ridges, and volcanoes. Natural vegetation ranges from the Olympic rain forest to interior high deserts.

The remainder of this chapter describes the purpose and need for this EIS. It is in two sections. The first outlines recent history, the scope of activities, and the issues that point to the need for this EIS. The second section presents related background information about the context of this EIS.

Three factors that are specific to the Region’s vegetation management program point to the need and purpose of this EIS: the history of events leading to this EIS; the relatively large scope of the vegetation management program; and current issues surrounding the program. This section outlines each of these three factors in sequence.

History

On June 2, 1981, the Forest Service issued a Final Environmental Impact Statement (FEIS) and Record of Decision on the Methods of Managing Competing Vegetation. The FEIS provided alternatives designed around different combinations of methods considered appropriate for vegetation management. Analysis for that FEIS considered all vegetation management activities, excluding only timber harvest and tree nursery operation.

The management decision was to implement a “full use of all methods of vegetation management, with reduced use of chemicals”, (Alternative 2). The reduction in chemical use was expected through consideration of local concerns, and through adherence to current law, regulation, policy, and guidelines.

A suit was filed in U.S. District Court for the District of Oregon on July 13, 1983 by Northwest Coalition for Alternatives to Pesticides (NCAP), Oregon Environmental Council, and Audubon Society of Portland against the Forest Service, Bureau of Land Management, and the Environmental Protection Agency.

Oregonians for Food and Shelter, an organization representing the business community, were intervenors on behalf of the government agencies.

A judgment was entered March 14, 1984, finding that "The defendants have not prepared an adequate Worst Case Analysis, pursuant to their NEPA obligations." An injunction against the use of herbicides in the Pacific Northwest Region of the Forest Service and Bureau of Land Management Districts in the State of Oregon was issued, until agency obligations were fulfilled.

Responding to the Court's directive, the Forest Service and the Bureau of Land Management prepared a comprehensive human health risk assessment for the use of herbicides, including a worst case analysis. This was intended to be part of a Supplement to the 1981 FEIS. After the preparation of that risk assessment, the Forest Service determined that a new EIS on the vegetation management program in the Pacific Northwest Region was needed.

The decision to prepare a new EIS was based on several factors. These included needs for:

- 1) re-evaluating the standards and guidelines in the 1981 document;
- 2) updating the issues and NEPA format requirements;
- 3) re-examining the management objectives for the entire vegetation management program, based on the current direction and philosophy;
- 4) responding to a new issue—air quality—by adding prescribed burning to the analysis;
- 5) including the human health risk assessment and worst case analysis; and
- 6) considering the plaintiffs' remaining claims for relief in the July 13, 1983 suit.

On July 17, 1986, a Notice of Intent was published in the Federal Register to announce the preparation of a new EIS for a vegetation management program in the Pacific Northwest Region.

Scope

Managing competing and unwanted vegetation is a relatively large program that covers a wide range of management activities in the National Forests. These include:

Reforestation site preparation and release: controlling vegetation that competes with young conifer seedlings.

Scope of the Program

Tree genetics support activities: controlling vegetation in the vicinity of parent trees used for high quality seed production.

Research: controlling vegetation on and around research sites, and where methods and techniques of managing vegetation are the subjects of investigation.

Recreation and administration facilities: removing unwanted vegetation from campgrounds, recreation areas, and administration sites to provide safety and an aesthetically pleasing appearance.

Range improvement: controlling plants (mostly invading brush species) that compete with desirable range plants.

Noxious weed control: controlling weeds (classified as noxious by Federal or state agencies) to protect crops, livestock, and land.

Wildlife habitat improvement: managing vegetation to benefit habitat for a wide variety of wildlife species.

Fire management activities: reducing or eliminating vegetation and woody debris to reduce fire hazards.

Rights-of-way maintenance: for safety and to protect the investment, controlling unwanted vegetation along highways and roads, land lines, trails, utility corridors, and railroads.

A detailed description of each of these activities requiring the management of unwanted vegetation is presented in Appendix G.

There are five general methods used in managing competing and unwanted vegetation. All are considered in this environmental impact statement. They are:

herbicides—chemicals used to kill or alter plants;

burning—the use of prescribed fire;

biological methods—the use of animals, insects, diseases, or other plants;

mechanical methods—the use of powered machinery; and

manual methods—the use of hand tools and hand-held power tools.

A detailed description of each of these methods is presented in Chapter II, Methods and Mitigation.

Issues

The Issues

The regulations for implementing NEPA require that the important environmental issues be identified early in the process, and that these issues serve as a basis for the alternatives.

These issues were distilled from the comments of the general public, interested groups, government agencies, and Forest Service people. They participated in early public involvement efforts that not only provided information on the issues the EIS should address, but also how the public could be involved throughout the whole analysis process.

Major issues play a substantial role in forming the alternatives; in raising questions for analysis; and (eventually) in focusing the thinking and discussion for selection of the preferred alternative(s).

After reviewing the material from the scoping sessions, and reading the comments from the public, agencies, and Forest Service employees, the interdisciplinary team identified seven major issues associated with the management of unwanted and competing vegetation.

The team continued to evaluate the appropriateness of those issues in light of ongoing comments received, and has found that they continue to capture the essence of concerns about vegetation management.

The seven public issues focusing this EIS are:

- human health;
- public participation;
- social and economic effects;
- costs and benefits;
- effectiveness of techniques;
- environmental effects; and
- interagency coordination.

A discussion of the issues is presented here, along with some representative comments received from the public during their involvement in early scoping efforts.

Health issues related to the management of vegetation have been a major focus during the past decade. Much attention has centered on the safety of herbicides used in vegetation control. The effects of smoke from prescribed burning has also emerged as an important health issue, along with the need to evaluate the health effects of using non-chemical methods of managing vegetation.

A 1984 court ruling regarding the original (1981) Forest Service environmental impact statement required the Forest Service to provide additional human health impact information pertaining to the use of herbicides for vegetation management. The ruling also required the agency to make its own evaluation of herbicides used in its programs, rather than depending—as it had in the past—upon the Environmental Protection Agency (EPA) for evaluation and registration of these herbicides.

Human Health

Comments received from the public during their involvement in early scoping efforts and related to the human health issue include:

"The heart of the issue is TRUST. You claim there are no persistent long term adverse health or environmental effects. How can you be sure and how can you convince me ... We are caught up in the ...ba[c]klash of other public entities that have promised health and safety to find out later it just wasn't so!"

[consider the] "safety of persons doing the work (ie: risks of getting cut by a chain saw or ax vs. chemical contamination)."

The goal of the Forest Service in dealing with human health issues is to create an environment of cooperation and understanding rather than an adversarial situation. Principal elements to be considered in evaluating the impact of various vegetation management techniques on human health include analyzing accidental, chronic, and perceived health risks. The scope of risks to be evaluated needs to include all methods of vegetation management, including use of herbicides, burning, manual, mechanical, and biological methods.



In addition, in the area of human health, what we don't know is often as important as what we do know. The relative certainty of information and the level and importance of missing information need to be carefully disclosed and considered.

Public Participation

Public participation is at the foundation of a successful program for managing public lands and natural resources. Public participation in vegetation management is an especially important and sensitive issue because of the past conflict-charged relations.

During the early scoping process where issues were identified, comments from the public emphasized *"the need to be square with the public,"* and the need to establish *"a conduit for release of preliminary plans and thinking...all along the way."* In response, Forest Service man-

agement has stated that, "The public [needs to] clearly understand the relationship of the EIS to site-specific decisions" toward the goal of "good relations with our Forest Service neighbors."

Members of the public have asked that our public participation process include:

- 1) participation throughout development of this EIS;
- 2) ongoing participation and information sharing to continue after the decision has been made;
- 3) participation in site-specific, project level planning; and
- 4) readable, clear and understandable analyses and documents.

Conflict related to resource management can be lessened when management activities occur under general consent. Making information fully available to all interested parties (in a readable, well-organized way) is a major part of achieving this.

Full public involvement and objective, thorough analysis of all relevant factors are also essential elements for informing all concerned.

Vegetation management activities have direct effects on employment and the quality of community life. The vegetation management program may influence how much timber the National Forests can grow and harvest. The quantity or quality of grazing, water, and other resource uses may also be affected. In the case of noxious weeds, for instance, National Forest activities need to be coordinated with those of owners of adjacent or intermingled lands to be truly effective. Inaction by any of these parties can adversely affect forage managed by the others.

The sale and harvest of National Forest timber directly supports jobs in the harvesting, transportation, and manufacturing sectors. It also supports jobs in many other sectors indirectly. Fees are collected for other Forest uses and products. A portion (usually 25 percent) of the gross revenues from timber sales and other fees are returned to local governments for support of their road and school systems. These direct and indirect effects have important ramifications for the social and economic viability of Northwest communities.

Comments received from the public during their involvement in early scoping efforts and related to the social/economic issue include:

"Address long term loss of production and business enterprises which would result from noxious weeds occupying native rangelands."

"Please consider labor intensive methods. Our society is in need of jobs."

"Emphasize 'greatest good to greatest number'."

Social and Economic Effects

"... (3) effects on Oregon's employment, (4) effects on Oregon's community stability, (5) effects on federal revenues to the counties. . . "

Much of the discussion about the use of manual treatment—to pick one vegetation management technique—has been in terms of jobs and other community effects. Advocates of use and non-use each argue that their approach is more beneficial for employment, either through increased employment in manual treatments or in employment in the wood products industry.

In addition to the economic effects of the alternatives, the different methods of managing vegetation on the National Forests have effects on the social cohesion and well-being of communities. Community conflict and anxiety over economic and environmental conditions may disrupt the stability of communities, and their "ways of life" may be changed.

The Forest Service is concerned with the economic and social health of local communities in the entire region. They are important factors in decisionmaking.

Costs and Benefits

The National Forests offer a wide range of goods and services. Some outputs—minerals and timber, for example—are sold or leased. The proceeds are returned to the U. S. Treasury. The dollar benefit for these outputs is recognized as being their market value—the buyer's willingness-to-pay in a competitive environment. There are other benefits associated with the production of these commodities which are not dollar-quantified. These include job satisfaction, job security, household stability and pride in workmanship.

Other uses of the Forests such as hunting, fishing, and hiking do not result in Forest receipts, yet have benefits associated with them. Recreationists certainly benefit from National Forests, often while paying only small user fees, or none at all. Providing free use of the Forest for these purposes does not diminish their value to the public.

A great many people expressed the desire that their money and their resources in the form of the National Forests, be wisely managed. Some samples of the comments received include

"A cost analysis for herbicides versus hand and mechanical methods of vegetation management should be done."

"Sound economic costs should be kept and used to weigh the value for each alternative."

"Ensure the benefits of vegetative management outweigh the costs."

"A thorough economic analysis of all methods will be needed."

"Public funding will continue to be tight so the least cost method that will adequately do the job needs to be used."

It costs money to manage unwanted or competing vegetation on the National Forests. It also costs money not to manage unwanted or competing vegetation insofar as this lack of management contributes to a reduced flow of benefits. It is important to carefully and continually analyze these costs and benefits as a new program is being developed.

There are many different vegetation management techniques and many different site characteristics and conditions. It is important to match the appropriate technique to the circumstance and particular site. Sharing knowledge of current techniques, products, and technology is an important aspect of this match. In addition, measures must be taken to assure the desired results are being achieved.

In determining what techniques are effective and striving to use "what works", many variables need to be considered, including:

- recognizing site limitations and environmental variables;
- examining up-to-date technology and knowledge for all methods;
- recognizing the desirability of taking advantage of natural processes; and
- monitoring treatments to verify that vegetation management objectives are actually being achieved.

Comments received from the public during their involvement in early scoping efforts that relate to the "effectiveness" issue, include:

"Realize that there are natural limitations on treatment options."

"Use new technology gained during the District Court... injunction."

"Herbicides may be the only means to rehabilitate certain woody brush and hardwood sites."

"No-action will sometimes provide the most desirable results."

Current Forest Service policy guidelines recognize the important role of effective use of natural and non-chemical methods of treating competing and unwanted vegetation (Forest Service Manual 2150). Realistic limitations on substituting one method for another must also be recognized. In addition, a balance needs to be found between how effective a method is and how much it costs.

The relative effectiveness of techniques and individual products can be broadly defined in an environmental analysis and used as a guide for site-specific decisionmaking. In addition, this analysis can be used as a tool to share what has been learned and to act as a beginning avenue for considering new technologies and products as they are developed.

Effectiveness of Techniques

Environmental Effects

All facets of the environment contribute to providing quality air and water, as well as a supply of timber, recreation, and wildlife. To produce a continuing supply of these and other benefits, the ecosystem must remain healthy. There is concern both within and outside the Forest Service about the physical and biological effects on the environment when applying vegetation management techniques.



Almost every comment received through the public involvement efforts during early scoping activities expressed concern and interest in the quality of the human environment:

"Protection of watershed areas, whether large or relating to individual property owned within the National Forest, needs to be a major consideration."

"My main concern is long range productivity and management of the land."

"Effects of not managing vegetation as it relates to the high buildup of fuels, large fire risk, change of species mix over time."

"Cumulative effects of vegetation management combined with other activities (harvest) on quantity and quality of food and cover for wildlife."

"Lightest touch rather than heaviest hand."

Recognition of the interrelatedness of biological and physical aspects of the forest is essential in evaluating the effects of vegetation management. Trade-offs between the potential environmental effects of one vegetation management method and another is also an important consideration.

For example, use of herbicides involves risk of drift into surface water, but using a substitute method such as burning may lead to loss of organic matter and accelerated erosion.

Some effects—such as erosion and compaction—need evaluation on a long-term basis. A site's potential to produce forage (or any other product) may consistently decrease over long periods, depending on what practices are used and how extensively they are applied.

Direct effects on the environment (such as a fire destroying trees) and indirect effects (the fire increasing the amount of forage available for deer) are another important component in evaluation of environmental effects.

Many of the effects on the physical and biological environment can be tied to the extensive use (or non-use) of particular vegetation management methods. If herbicides are used regularly, certain effects may be predicted. If mechanical methods are the predominant technique, then certain other effects may result. What methods are used for and how they are applied are important keys in predicting environmental effects.

Agencies at all levels of government have a shared interest in resource management through vegetation manipulation. Many agencies have responsibilities for vegetation management that overlap Forest Service responsibilities. Many may be directly affected by decisions made in an environmental analysis; others indirectly.

Federal agencies especially involved in vegetation management issues include the Bureau of Land Management (BLM), and the Environmental Protection Agency (EPA). The BLM is a joint defendant in the lawsuit (NCAP et al.) that eventually led to the District Court injunction on herbicide use. Strategies to meet NEPA regulations and other legal requirements need to be closely coordinated and developed with the BLM.

Program decisions made as a result of this environmental impact statement may have an impact on a number of state agencies that share either statutory authority or regulatory responsibilities. These include state departments of environmental quality, forestry, health, and agriculture. Coordination is particularly important in the areas of air quality, smoke management, and herbicide use, registration, and quality control. Decisions made for the vegetation management program may have implications or ripple effects for agencies dealing with agriculture or health services.

Local agencies have a stake in this environmental impact statement because of possible effects on payments to local governments, and on the effectiveness of programs such as noxious weed control. Coordination with county weed boards, conservation districts

Interagency Coordination

and other county officials needs to be part of any interagency coordination effort.

Formal cooperation (established through provisions in NEPA) in the development of the EIS is an appropriate role for some state and federal agencies. A major outcome of any cooperative effort would be a clarification of agency responsibilities and improved channels of communication.

“The NEPA Process”

The primary purpose of an environmental impact statement (EIS) is to assure that the policies and goals of the National Environmental Policy Act of 1969 (NEPA) are incorporated into federal actions. EIS's are written to make all pertinent environmental information and analyses available to public officials, cooperating agencies, and citizens before decisions are made and actions are taken.

All Forest Service activities that affect the physical and biological environment are regulated in part by NEPA.

NEPA is our basic national charter governing federal actions and the environment. It establishes several means to “create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.”

NEPA is implemented through regulations in Title 40 of the Code of Federal Regulations, Parts 1500-1508 (40 CFR 1500-1508). The Forest Service implements NEPA according to “Environmental Policy and Procedures”—Chapter 1950 in the Forest Service Manual (FSM 1950). Further guidance is in the “NEPA Procedures Handbook” (FSH 1909.15). We will refer to these three throughout this EIS.

The process of analyzing and disclosing environmental consequences and then making and implementing a decision is often called “the NEPA process.” It is a flexible but orderly process that is used to look at the environmental effects of a wide variety of actions. It is specifically spelled out in Forest Service Manual 1950 and Handbook 1909.15, but the principal elements are described here.

Environmental Analysis

The core of the process is “environmental analysis.” It is required for large projects and plans making major changes to the environment, as well as routine activities with a clear record of no significant environmental effects. The “environmental analysis” may be documented in a published “environmental impact statement”, such as this one; documented in an “environmental assessment” (EA); or not documented at

all if the activity is "categorically excluded" and has no significant effects. (See Figure I-2).

The first step in environmental analysis is "scoping." In scoping, the need, context, and issues related to a proposed action are considered. Public involvement needs are assessed and public participation actions may be started at this point. The needed environmental analysis is planned, along with plans for documenting that analysis if it is to be presented in an EA or EIS (FSH 1909.15, Chapter 10). An interdisciplinary team may be formed to conduct the environmental analysis. This is the time when issues and analyses are made more explicit, and alternatives explored.

Continued environmental analysis involves a number of steps. As scoping serves to assure the appropriateness and responsiveness of the environmental analysis, it continues throughout the analysis. The steps include:

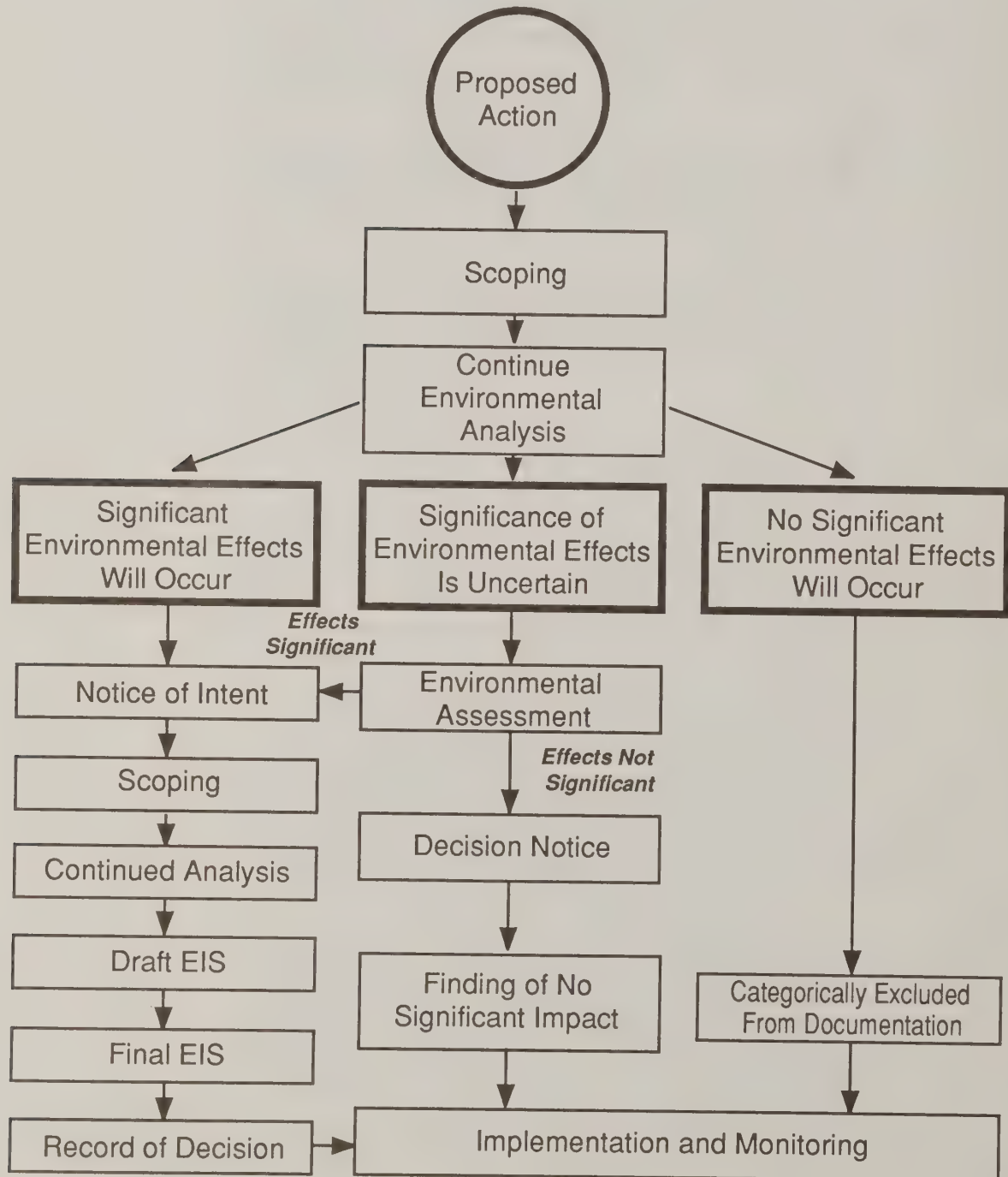
- scoping;
- informing the public;
- collecting and interpreting data;
- developing alternatives;
- estimating effects of each alternative;
- evaluating the alternatives;
- identifying (a) preferred alternative(s);
- deciding to implement the action; and
- monitoring its effects and results.

As mentioned earlier, following the selection of a preferred alternative for action and the decision to implement it, the activity or project is "monitored" to assure that results and environmental protection are as planned, and that the activity or project is stopped or changed to meet the desired protection or results. Monitoring may find and document conditions sufficient to start a new environmental analysis.

Unless "categorically excluded" from the need for documentation, the environmental analysis will be reported in a document. If the proposed action does not have significant environmental effects, the document is an "environmental assessment". If the actions might have significant effects (like the action proposed here), it is documented in a draft environmental impact statement (DEIS) such as this one.

Figure I-2

Environmental Analysis, Documentation, and Implementation of "The NEPA Process"



Future Steps for This EIS

After review of this DEIS by the public and interested government agencies, and after the interdisciplinary team considers and responds to substantive comments on the analysis and the document, a final environmental impact statement (FEIS) on managing competing and unwanted vegetation will be prepared and distributed.

Based on information in the FEIS, the responsible official (the Regional Forester, in this case) will select a course of action (based on the preferred alternative in the FEIS), and present the reasons and conditions in a document called the Record of Decision.

From that point, people working in the National Forests will begin implementing the program selected, keeping a close watch on the environmental effects and results of the management activities on the environment.

The vegetation management program in the Pacific Northwest Region will incorporate hundreds of site-specific projects across the Region over several years. The environmental consequences of each one of them will be different, depending on the characteristics of the land, vegetation, and animals on that site; the weather and the time of year; and on how the activity is conducted.

The environmental consequences particular to each project and site will be estimated in a site-specific environmental analysis. Where the impacts found are not significant, this analysis is documented in an "environmental assessment". Where the activity is routine, has minor impacts (and is listed in the categories in Forest Service Manual 1952.2) the environmental analysis may be "categorically excluded" from documentation. Where site-specific environmental analysis finds that an activity will have significant impacts, however, an environmental impact statement will be prepared.

Ties to Forest Plans

The Forest Service has an extensive, three-level process for planning for the management of land and resources of the National Forests. In addition to 1) the Forest Plans now being developed for each National Forest in the Region, there is 2) a Regional Guide for the Pacific Northwest Region (1984), and 3) national guidance in the Resources Planning Act (RPA) Programs (1980 and 1985). The information and direction developed at each level is based on the information and direction in other levels.



The Forest Plans are based on extensive analysis of resource capability, environmental effects, and economic factors. They designate parts of the Forests to different mixes of uses; schedule activities; determine appropriate levels of production; and establish standards and guidelines to safeguard environmental quality and long-term productivity.

Vegetation Management and Forest Plans

Projects that manage unwanted and competing vegetation help accomplish the goals and meet the standards established by the Forest Plans.

This environmental impact statement (EIS) looks at those vegetation management projects collectively as a program, and analyzes and discloses their environmental impacts. In addition, it presents their implications for the cost and amount of work needed to manage the Forests.

Analyses and choices made in the Forest planning process are based on detailed data and familiarity with local conditions. While this EIS does display the Region-wide management implications of the alternatives, it does not specifically change any allocation or expected output level in the Forest Plans.

Decisions based on this EIS could affect the Forest Plans. The Forest Plans were (and are being) developed with the assumption that all methods of managing vegetation were available. The vegetation management program ultimately selected by the Regional Forester could well be different from that currently assumed in Forest Planning.

If the vegetation management program selected is different from that currently assumed, the Forest Supervisor on each National Forest will need to examine the overall resource management implications of the new vegetation management program.

If the new vegetation management procedures and mitigation measures would change the way lands and resources would be

managed on a National Forest, then changes in the Forest Plan would be needed.

These changes can be analyzed and presented in different ways, depending on the stage of development each Forest Plan is in. Changes can be incorporated: 1) in the Proposed Plan before the publication of the Proposed Plan and its DEIS; 2) as a Revised Proposed Forest Plan and its Revised DEIS; 3) incorporated in the Forest Plan and its FEIS; or 4) as a revision to a Forest Plan already in effect.

The information in this EIS will enable the Regional Forester to select a vegetation management program for the Region. Cost, environmental effects, and production implications will be part of that information. That decision does not specifically change the Forest Plans. However, Forest Supervisors and their planning teams must evaluate the effect of the new vegetation management procedures on their own Plan, and make revisions as needed.

Major Legislation Relating to This EIS

- The National Environmental Policy Act of 1969 (as Amended) (NEPA)
- Federal Environment Pesticide Control Act of 1972 (FEPCA)
- Federal Pesticide Act of 1978 amending the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
- Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA)
- The National Forest Management Act of 1976 (NFMA)
- Environmental Quality Improvement Act of 1970
- The Clean Air Act (Section 309)

Summary

Managing competing and unwanted vegetation in the Region is a large program that has the potential for significant environmental consequences. The public continues to be concerned with the program and its related major issues. There is a need to evaluate alternative ways of managing competing and unwanted vegetation, and the environmental consequences of those alternatives. This EIS responds to that need.

2.0 Purpose and Need

The purpose of this study is to determine the need for a new bridge over the river. The study will be conducted in three phases. The first phase will be to determine the need for a new bridge. The second phase will be to determine the location of the new bridge. The third phase will be to determine the design of the new bridge. The study will be conducted by a team of experts in the field of bridge engineering. The study will be completed by the end of the year. The results of the study will be used to determine the need for a new bridge and to determine the location and design of the new bridge. The study will be a valuable contribution to the field of bridge engineering.

Chapter II

The Alternatives

2

Chapter II

The Alternatives

The alternatives are the heart of an EIS. Once the issues are characterized, alternative ways of resolving the issues and resource management needs become the focus of the environmental analysis process. The environmental consequences and management implications of the different alternatives are analyzed, evaluated, and compared. This forms the basis for an informed decision on which course of action to follow.

All of the material pertaining the alternatives is here, or is summarized here, in this chapter. It is a large chapter, and a complex one.

How This Chapter Is Organized

Alternative Descriptions. First the alternatives are described. The description of each alternative presents the methods, tools, and process that would be used in managing competing and unwanted vegetation if that alternative were selected.

Alternative Comparisons. The environmental consequences and the management implications of the alternatives are compared to each other. These comparisons are organized around the seven issues identified in Chapter I. Much of the information for the comparisons comes from Chapter IV.

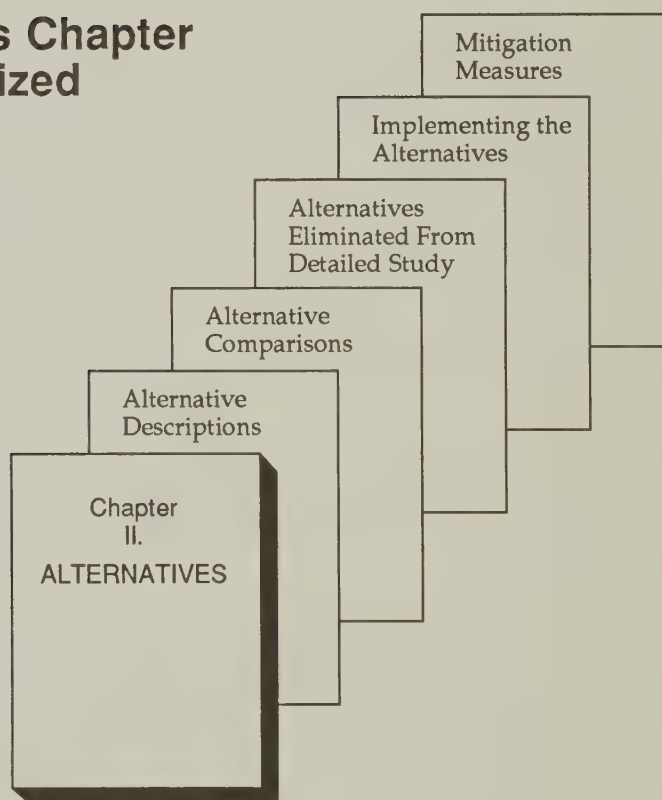
Alternatives Eliminated from Detailed Study. This short section describes several alternatives that were considered, but were not analyzed in as much detail as the principal alternatives.

Implementing the Alternatives. This section expands on the steps that will be involved in managing competing and unwanted vegetation in the field, whichever alternative is selected. It explains the tie between the required site-specific environmental analysis and the special emphases for vegetation management projects.

Mitigation Measures. The final section of this chapter presents the special measures that will be used to avoid or minimize the potential environmental impacts of managing competing and unwanted vegetation.

Figure II-1

How This Chapter is Organized



Chapter 2
The Alternatives

Description of
the Alternatives

Description of the Alternatives

This section begins with a brief introduction to the alternatives, followed by a two-page overview of the alternatives. Then methods, tools, and operation of each alternative are described.

This Environmental Impact Statement (EIS) is a "program EIS," disclosing the environmental effects of a program that may have hundreds of specific projects. The alternatives here present different ways of managing competing and unwanted vegetation on all National Forests in the Region.

The alternatives provide different instructions to the people analyzing, designing, and carrying out vegetation management in the Region. The alternatives differ in the kind and degree of instruction given.

All the alternatives require a site-specific analysis of the vegetation management situation before work starts, as part of an environmental analysis to explore options and to discover the environmental consequences of the proposed project. All alternatives assure the public of information about vegetation management projects.

The resource management philosophy of all the alternatives is to intensively manage resources, meet Forest Service program goals, and to have minimal adverse effects on the environment.

A Program EIS

Figure II-2

Overview of the Alternatives

Alternative	A	B	C
Manages Competing and Unwanted Vegetation	...with no herbicides.	...with all effective tools.	...rarely, and only for human safety.
Time for Action	At first sign, before damage occurs.	At first sign, before damage occurs.	No action unless vegetation threatens public safety.
Project Design	Prevention and correction both o.k.; herbicides will not be used.	Prevention and correction both o.k.; all tools and methods available.	Correction only; fire and herbicides both prohibited.

D	E	F	G
...with prevention and natural processes.	...with herbicides restricted and special worker safety.	...with no burning for silviculture.	...aggressively, with all tools.
At first clear sign of potentially significant damage.	At first sign, before significant damage occurs.	At first sign, before damage occurs.	At first sign, before damage occurs.
Prevention is preferred; herbicides available as a last option.	Prevention is preferred; some herbicides prohibited, no aerial application; manual use restricted.	Prevention and correction o.k.; fire will not be used to treat slash or prepare planting sites.	Prevention and correction o.k.; all tools and methods freely available.

Alternative A

Purpose and Theme

This alternative is designed to eliminate all risk associated with the use of herbicides in managing competing and unwanted vegetation. Other effective and efficient techniques are to be used.

Alternative A approximates the current vegetation management program, carried into the future. Herbicides are not currently available as a management tool, due to the U.S. District Court injunction of 1984.

Time for Action

The need for action is evaluated at the first sign of any competing or unwanted vegetation that could potentially damage wanted species or desired conditions. The intent is to eliminate or reduce competition or hazards before there is damage to wanted species or conditions. For example, the presence of seeds and proper conditions for germination of snowbrush ceanothus on a newly harvested unit may trigger an evaluation of the need for control.

If information is incomplete about specific damage relationships or the effectiveness of methods on a specific site, the manager should act to assure that program goals are met (even if a "wait and see" approach might eventually reveal minimal damage or more efficient methods). Regardless of whether control is applied, monitoring and evaluation are essential.

Project Design

The factors to consider in designing projects are as follows:

Strategy: The most appropriate strategy for a given situation will be implemented, with no predisposition toward either prevention or correction.

Human Health Risk: As in all alternatives, the potential for risk to human health is of concern in selecting a vegetation management technique. Under this alternative, avoiding herbicides eliminates any risk associated with them, while increasing risks from substitute methods. All techniques being considered will be analyzed for potential direct and indirect effects on human health prior to action. The selected technique will have low risk when compared to other suitable techniques that also meet other design criteria.

Environmental Effects: Most adverse effects in both the long and short-term will be minimized by following the appropriate land management documents, and additional mitigation measures described in this EIS. These documents specifically address diversity, long-term productivity, and ecosystem functions on a site-specific basis. In the face of uncertainty concerning effects of a particular tool,

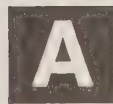
the manager will balance the potential for an adverse environmental impact with cost and benefits.

Tools Available: The use of herbicides to control competing and unwanted vegetation is prohibited; all other tools and techniques are permitted.

The use of tools has and will continue to change, based on new research, the analysis of completed projects, improvements in technology, and public need. To minimize environmental effects and sustain long-term productivity, National Forest managers are continuing to evaluate tools and intensity of application.

Budget and Costs: The costs of the activities will vary, but will generally not exceed budgets that can be reasonably expected.

Outputs: Vegetation management activities will be those required to support the production of Forest commodities at a level approximating those of the applicable land and resource management plans.



Alternative B

Purpose and Theme

All effective and efficient techniques for managing competing and unwanted vegetation are available, consistent with the direction provided in applicable land and resource management plans.

The management of competing and unwanted vegetation specified in this alternative approximates the direction presented in proposed Forest Plans. The fiscal year 1989 program serves as the reference for budgets, outputs, and vegetation management activities for all alternatives.

Time for Action

The need for action is evaluated at the first sign of any competing or unwanted vegetation that could potentially damage wanted species or desired conditions. The intent is to eliminate or reduce competition or hazards before there is damage to wanted species or conditions. For example, minimizing soil disturbance in an area where noxious weeds are likely to invade, or timely planting or seeding of roadsides with low herbs and shrubs, reduces the need for vegetation control activities.

If information is incomplete about specific damage relationships or effectiveness of methods on a specific site, the manager should act to assure that program goals are met (even if a "wait and see" approach might eventually reveal minimal damage or more efficient methods). However, monitoring of results is essential to assess the method and fine tune future applications.

Project Design

The factors to consider in designing projects:

Strategy: The most appropriate strategy for a given situation will be implemented, with no predisposition toward either prevention or correction.

Human Health Risk: Methods will be analyzed for risk to human health and safety prior to use. Results will be monitored and records will be reviewed and analyzed to evaluate health effects on all methods. Mitigation measures, if needed, will be incorporated into project design to minimize potential impacts on human health. Chemicals approved by the EPA are acceptable after Forest Service review.

Environmental Effects: Adverse effects in both the long- and short-term will be minimized by following the appropriate land management planning documents, and by additional mitigation measures described in this EIS. These documents specifically address diversity, long-term productivity, and ecosystem functions on a site-specific basis. In the face of uncertainty concerning effects of a particular tool,

the manager will balance the potential for an adverse environmental impact with cost.

Tools Available: All tools and techniques are permitted. The use of tools has and will continue to change, based on new research, the analysis of completed projects, improvements in technology, and public need. To minimize environmental effects and sustain long-term productivity, National Forest managers are continuing to evaluate tools and intensity of application. Opportunities to reduce the use of herbicides will be sought.

Budget and Costs: Projects to manage unwanted vegetation will not exceed the FY 1989 Forest program budget. The methods selected will be the most cost-efficient means to meet the management objectives.

Outputs: Vegetation management activities will be those required to support the production of Forest commodities at a level approximating those of the applicable land and resource management plans.

B

Alternative C

Purpose and Theme

The vegetation management approach here is one of “no action” unless public safety is clearly and directly threatened. For example, hazard trees will be removed from campgrounds, and roadside brushing will be done to maintain safe travel, but virtually all of the vegetation management normally associated with forest management will not be done. Some resource production objectives may not be met.

There is virtually no active intervention to manage competing and unwanted vegetation in Alternative C. Only situations that pose a direct threat to public safety will trigger action to suppress unwanted vegetation; and in these cases, neither herbicides nor fire will be used.

This alternative is the “no action” alternative required by regulation (40 CFR 1502.14). While it serves an important analytic role, it is also an alternative that could be implemented if it were selected. However, it is a dramatic departure from the manner in which the Forests have historically been managed.

Public involvement will occur infrequently, primarily because of little or no vegetation management activities. If a vegetation management project is proposed, NEPA guidelines will guide the public involvement efforts.

Time for Action

Action will not occur unless there is a direct threat to public safety. While little active intervention occurs, there will still be some management of unwanted vegetation.

Because of the nature of this alternative, Forests are expected to have no vegetation management in the following activity areas:

- site preparation and release;
- tree genetics support activities;
- research;
- range improvement;
- noxious weed control;
- wildlife habitat improvement; and
- prescribed burning.

Project Design

The factors to consider in designing projects include:

Strategy: No action will be taken until the vegetation is clearly identified as a direct threat to public safety. Correction, as opposed to prevention or maintenance, will be the most common approach.

Human Health Risk: Health risks associated with methods of treating vegetation will be eliminated, except for the occasional case where vegetation management is used to eliminate a direct threat to public safety.

Environmental Effects: Existing Federal laws and regulations will be met; however, compliance at the state level with state regulations and the state Forest Practices Act may not occur.

Tools Available: Chemical and thermal techniques are both prohibited. All other tools and techniques are permitted as necessary.

Budget and Costs: The method with minimal initial cost will be utilized. Only fuel treatment which removes a direct threat to public safety (such as fuel management in inhabited sites) will be done.

Outputs: There are likely to be changes in outputs from those stated in the applicable land and resource management plans.



Alternative D

Purpose and Theme

The key to this alternative is the integration of natural ecosystem processes into managing competing and unwanted vegetation. Here, vegetation management emphasizes the implementation of the philosophy of having the least impact on the natural environment while producing products and amenities for human use.

The implementation of the alternative will involve early preventive measures, monitoring of sites, and frequent evaluations of conditions and practices. Vegetation is managed to avoid the need for corrective measures; however, correction, if needed, is done in a way to least alter natural ecosystems and processes. It requires the consideration of the health of those ecosystems as seen in conditions such as growth and diversity.

This alternative places an increased emphasis on early involvement of the public in environmental analysis procedures, and on carrying this participation through to project implementation and monitoring.

Time for Action

Action is called for at the first clear sign of potentially significant damage from unwanted vegetation. The project planning stage is the most appropriate stage for implementing a prevention strategy. For example, site analysis may identify a plant association known for its potential to compete with crop trees. The harvest prescription may then include measures to limit the vigor of competing vegetation. The result may lessen the need for subsequent corrective action (in this case, release) and result in lower overall costs. Action will be taken when conclusive evidence—or documented local experience, such as site-specific surveys—indicates that significant damage or growth loss will occur.

Project Design

The factors to consider in designing projects include:

Strategy: Prevention is the preferred strategy for pre-empting vegetation problems. Intervention with corrective measures will be used if preventive measures alone are infeasible, inappropriate, or when unacceptable vegetative conditions have resulted from the design and execution of projects prior to the adoption of this EIS.

Human Health Risks: Minimizing human health risks is important in selecting techniques. All techniques will be analyzed for risks prior to action. The selected technique will have low risk when compared to other suitable techniques which meet other design criteria. Mitigation measures, if needed, will be incorporated into project design to minimize potential impacts on human health.

Environmental Effects: Minimizing adverse environmental effects is also important in selecting techniques. As with other alternatives, the potential environmental effects will be fully explored before taking action that may adversely affect long-term productivity or the diver-

sity and integrity of the natural ecosystem. In the face of uncertainty, the manager will select a technique that minimizes potential adverse effects on ecosystem structure and function.

Tools Available: The preferred tools are those which prevent damage from unwanted or competing vegetation through the design and execution of silvicultural, construction, and other resource management projects to avoid creating or intensifying problem vegetation.

As a result, corrective action, which corrects a problem once the competing or unwanted vegetation is already well established, is not needed as much as in the past. Generally, corrective actions include slash disposal, suppression of competing vegetation for planting or release, spraying or brushing rights-of-way, and suppression of noxious weeds. Although these actions are usually considered corrective, it is the intensity, frequency, extent, and timing of their implementation that sometimes distinguishes a corrective action from a preventive action (refer to the section in this chapter that discusses the five steps in managing vegetation for definitions and examples of corrective and preventive actions).

Specifically, the Forests' use of a prevention strategy to control unwanted and competing vegetation may result in a reduction—ranging from 30 to 60 percent Regionally—of acreage historically treated with a corrective action in the last five years (1981-1985). (For herbicide use, the five-year period prior to the 1984 injunction is used.)

In the Coastal Forests, a higher percentage of the acreage may need corrective treatment, although an overall reduction of treatment need is expected. The East-side Forests, on the other hand, may experience a greater overall reduction in treatment needs, and a higher than average reduction in corrective activities. Most important, preventive actions will tend to increase over time, and corrective actions will decrease.

Herbicides are available under this alternative, but will be the last option considered. Herbicide use is expected to be reduced significantly (ranging from 40 to 70 percent from the historic five year period). Some programs will require a gradual reduction. Road maintenance, for example, must work with a road system developed under a different strategy. Conversion will be costly and require a cautious approach, learning as feedback is accumulated and analyzed.

As market opportunities allow, utilization of logging slash will be encouraged, to reduce the total on-site tonnage burned. (Fifty percent or less of the average historic acres will be treated.) Prescribed fire is available in conjunction with specific determination of site conditions and probable post-burn vegetation response. The need for coarse woody debris for long-term site productivity is recognized.

Budget and Costs: The costs of the activities will vary, but will generally not exceed budgets which can be reasonably expected.

Outputs: Vegetation management activities will be those required to support the production of Forest commodities at a level approximating those of the applicable land and resource management plans.

D

Alternative E

Purpose and Theme

This alternative is designed to reduce the risks of herbicide use to the public, and to reduce the risk of herbicide use and manual vegetation treatments to forest workers. No aerial application of herbicides is permitted; specific herbicides are prohibited; and additional safety requirements for workers are imposed.

Time for Action

Action would be taken when significant damage, or the clear potential for such damage, occurs to a desired species or vegetative system.

If complete information is lacking as to a specific damage relationship or the effectiveness of methods on a specific site, the manager will take an approach that assures protection of human health. For example, yarding of logging slash may be preferred over burning in an area where smoke is likely to accumulate in populated areas.

Project Design

The factors to consider in designing projects include:

Strategy: Prevention is the preferred strategy, except where correction is either the only feasible approach, or can be shown to incur lower cost or environmental impacts.

Human Health Risk: This is the major concern and driving force in selecting a vegetation management technique. The potential for direct and indirect health effects will be analyzed before taking any action that might pose a risk to human health. The selected technique will pose the lowest risk to human health.

Environmental Effects: Adverse effects in both the long- and short-term will be minimized by following the appropriate land management planning documents and any additional mitigation measures described in this EIS. These documents specifically address diversity, long-term productivity, and ecosystem functions on a site-specific basis. In the face of uncertainty concerning effects of a particular tool, the manager will balance the potential for an adverse environmental impact with cost.

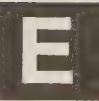
Tools Available: All tools and techniques are available with the following exceptions:

- 2,4-D, Amitrole, Diuron, and Fosamine will not be used in any application.
- Backpack and ground applications of herbicides may be used, but there will be no aerial applications. Bromacil, 2,4-DP, and Simazine will not be used in backpack spray applications.

- Other Forest Service-reviewed herbicides may be applied using backpack spray techniques only after completion of training beyond the standard certification training for all workers. Applications will be limited to brush of a more restrictive, specified height and density.
- The use of power tools will require operator safety training and proper protective gear, and will not be used in brush that is too high or dense for safe operation. This is not meant to preclude hand-construction of firelines in emergencies.
- Burning of herbicide-treated vegetation is prohibited. Use of chemicals in watersheds formally designated as municipal or industrial watersheds is prohibited. Residue utilization will be a priority before burning of slash can be considered. However, prescribed burning is fully available for treating natural fuels.

Budget and Costs: The costs of the activities will vary, but will generally not exceed budgets which can be reasonably expected.

Outputs: The vegetation management activities will be those required to support the production of Forest commodities at a level approximating those expected in applicable land and resource plans.



Alternative F

Purpose and Theme

This alternative is designed to manage competing and unwanted vegetation without the use of prescribed fire for silvicultural purposes. All other effective and efficient techniques of vegetation management are available.

The burning of logging slash would be allowed only to reduce wildfire hazard. Residue utilization would be encouraged in place of burning, and burning of chemically treated vegetation would be prohibited.

Time for Action

Action is called for at the first sign of any competing or unwanted vegetation that could potentially damage wanted species or desired conditions. The intent is to eliminate or reduce competition or hazards before there is damage to wanted species or conditions.

If information is incomplete about specific damage relationships or the effectiveness of methods on a specific site, the manager acts to assure that program goals are met (even if a “wait and see” approach might eventually reveal minimal damage or more efficient methods).

Project Design

The factors to consider in designing projects include:

Strategy: The most appropriate strategy for a given situation would be implemented, with no predisposition toward either prevention or correction.

Human Health Risk: The potential for risk to human health is of concern in selecting a vegetation management technique. All techniques being considered will be analyzed for risk prior to action. The selected technique will meet other design criteria and have a low risk to human health.

Environmental Effects: Adverse effects in both the long- and short-term will be minimized by following the appropriate land management planning documents, and additional mitigation measures described in this EIS. These documents specifically address diversity, long-term productivity, and ecosystem functions on a site-specific basis. In the face of uncertainty concerning effects of a particular tool, the manager will balance the potential for an adverse environmental impact with cost.

Tools Available: Prescribed fire will not be used to treat logging slash for site preparation. Burning of logging slash will be allowed only for protection purposes, and then only if no other vegetation management tool will achieve the same hazard reduction. The Fuel Appraisal

Process will be used to determine whether or not slash will be treated to reduce wildfire hazard. Prescribed fire may be used for treating natural fuel accumulations for reducing wildfire hazard, wildlife habitat improvement, and range improvement.

Use of chemicals that are approved by the EPA for controlling competing and unwanted vegetation will be allowed after Forest Service review. Burning of chemically treated vegetation will be prohibited.

Budget and Costs: The costs of the activities will vary, but will generally not exceed budgets which can be reasonably expected.

Outputs: The vegetation management activities will be those required to support the production of Forest commodities at a level approximating those expected in the applicable land and resource management plans.

Alternative G

Purpose and Theme

This alternative manages competing and unwanted vegetation aggressively, to maximize production of resources for human use. All techniques for managing vegetation are available.

Time for Action

Action is called for at the first sign of any competing or unwanted vegetation that could potentially damage wanted species or desired conditions. The intent is to eliminate or reduce competition or hazards before there is any damage to wanted species or significant reduction in growth or outputs.

If information is incomplete about specific damage relationships or effectiveness of methods on a specific site, the manager should act to assure that program goals are met or exceeded (even if a “wait and see” approach might eventually reveal minimal damage or more efficient methods). Site preparation, release activities, and noxious weed control activities are consistently applied to maximize early growth and production of forage.

Project Design

The factors to consider in designing projects include:

Strategy: The most appropriate strategy for a given situation will be implemented, with no predisposition toward either prevention or correction.

Human Health Risk: Methods will be analyzed for risk to human health and safety prior to use. Mitigation measures, if needed, will be incorporated into project design to minimize potential impacts on human health. Chemicals approved by the EPA are acceptable after Forest Service review.

Environmental Effects: Adverse effects in both the long- and short-term will be minimized by following the appropriate land management planning documents, and additional mitigation measures described in this EIS. In the face of uncertainty concerning effects of a particular tool, the manager will balance the potential for an adverse environmental impact with the benefits of increased resource production.

Tools Available: All tools and techniques are available to the Forest manager. The use of tools has and will continue to change, based on new research, the analysis of completed projects, improvements in technology, and public need. To minimize environmental effects and sustain long-term productivity, National Forest managers will continue to evaluate tools and intensity of application.

Budget and Costs: Projects to manage unwanted vegetation may exceed the fiscal year 1989 Forest program budget.

Outputs: Vegetation management methods will be used to attempt to exceed the anticipated Forest commodity production levels in the applicable land and resource management plans. Commodity production should not drop below those levels projected for the years after the current Forest Plan.



The Preferred Alternatives

Alternatives B, D, and E are identified as the Forest Service's "preferred alternatives."

Regulations require the EIS to "identify the agency's preferred alternative or alternatives, if one or more exists, in a draft statement and identify such alternative in the final statement." (40 CFR 1502.14(e)).

The interdisciplinary team evaluated the alternatives and recommended Alternatives B, D, and E as the preferred alternatives. The Regional Forester reviewed that recommendation with his staff and selected these alternatives as the preferred alternatives in this DEIS.

All three alternatives will permit the Forest Service to fulfill its statutory mission and responsibilities, considering economic, environmental, and technical factors. The three alternatives also respond to the range of issues.

After review by the public and other agencies, and after consideration of substantive comments on the DEIS, a preferred alternative will be selected and appear in the FEIS.

Chapter 2
The Alternatives

Comparing
the Alternatives

Comparing the Alternatives

One of the most interesting and revealing sections in an environmental impact statement is the comparison of alternatives. The comparison highlights similarities and differences between alternatives and strives to give readers a better understanding of each scenario. It allows the reader to begin differentiating between alternatives and deciding which ones best meet their ideas, concerns, and issues.

We encourage you to refer to this section often as you read, think about, and comment on other parts of this EIS.

This section compares alternatives by presenting:

- an overview of how alternatives respond to issues (Figure II-3);
- a detailed narrative comparison of alternatives by issue; and
- a series of tables that estimate effects and suggest implications for each alternative.

Figure II-3

How Alternatives Respond to Issues

ISSUES	UNIT OF MEASURE	ALTERNATIVE
A		
Human Health	Qualitative risk assessment	Eliminates risk from herbicides. Increased risk from other methods. Reduces perceived risk by public.
Public Participation	Guidelines for project planning	Same as Alternative B.
Social & Economic Effects		
– Change in payments to local governments	Million \$ per year	– 4.9
– Change in personal income	Million \$ per year	– 28
– Change in jobs	Number of jobs	– 1,100
– Predicted change in LTSYC* capacity (over full rotation)	% Change Million Board Feet	– 2-1/2 to 3% – (95 to 125)
Cost/Benefit Analysis		
– Change in Present Net Value	Million \$	– 468
– Change in Forest Service Budget	Million \$	+ 1
Environmental Effects		
– Long-term productivity	Biomass Production	Same as Alternative B.
– Air quality (All alternatives meet state TSP** reduction goals by the year 2000.)	Reduction of TSP emissions from current levels by the year 2000	West-side levels reduced by 36%; East-side levels reduced by 35%.
Effectiveness of Techniques	Quality of tree establishment and early growth (Commercial species)	Some problems in tanoak-madrone, ceanothus spp. and herbaceous veg., leading to tree mortality and growth loss in new plantations.
Interagency Coordination	Guidelines for project planning	Same as Alternative B.

* LTYSYC: Long-Term Sustained Yield Capacity (for timber production). This is the average for all 19 National Forests. The change will be much greater on some forests; less on others. The annual timber sale quantity will be determined in individual Forest Plans. See Chapter IV.

**TSP: Total Suspended Particulates (smoke).

*** Reference: Level expected with implementation of the Forest Plan.

B	C	D	E	F	G
Historical risk pattern continues. Problems with perceived risk continue.	Little risk from managing vegetation. Some increased risk from noxious weeds and travel accidents.	Risk decreases through prevention. Because of less treatment, perceived risks lowered.	Risk to public reduced. Risks to workers near current levels, despite extra safety measures. Perceived risk lower.	Risks from fire and smoke reduced. Increase in herbicide use. Perceived risks probably higher.	Risk to public and workers increases because of more treatment. Perceived risks increased.
Interested public informed and involved in vegetation management.	Involvement infrequent due to few projects.	As in Alternative B, with increased emphasis is on early involvement through to project implementation.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.
Reference***	- 57.1	- 7.4	- 4.3	- 8.4	+ 2.6
Reference	- 533	- 76	- 33	- 75	+ 63
Reference	- 21,800	- 3,100	- 1,400	- 3,100	+ 2,600
Reference	- 25 to 50% - 1,000 to 2,000	- 1-1/2 to 2% - 55 to 85	- 1 to 1/2% - 35 to 65	- 2-1/2 to 3% - 95 to 125	+ 2-1/2 to 3-1/2% + 95 to 125
Reference	- 3,877	- 246	- 132	- 322	+ 24
Reference	- 126	- 21	- 9	- 19	+ 20
Continuation of current conditions, as modified by applicable land and resource management plans.	Substantial loss; fire increases above current and natural levels, results in soil damage.	Slight increase from leaving biomass on site, fire risk managed, nutrient availability will increase.	Same as Alternative B.	Same as Alternative B.	Slight decrease. Aggressive control and residue use results in less biomass, nutrients on site. Less mechanical and fire damage to soils.
West-side levels reduced by 33%; East-side levels reduced by 35%.	No burning for silviculture; but substantial increases in wildfire and smoke.	West-side levels reduced by 63%; East-side levels by 60%.	West-side levels reduced by 46%; East-side levels reduced by 37%.	West-side levels reduced by 63%; East-side levels reduced by 53%.	West-side levels reduced by 35%; East-side levels reduced by 31%.
Continuation of current techniques (with herbicides restored to use).	No vegetation management.	Minor reduction in effectiveness on some existing problem sites; future techniques will draw on experience with preventive measures, effectiveness will be near current levels.	Effectiveness reduced in dense vegetation and steep terrain.	Effectiveness reduced in plantations with large amounts of competing vegetation or logging residue.	Some marginally suitable land will come under management. Stocking levels will increase in some areas.
Coordination with State and local agencies required in project design.	Little coordination, as no management of most competing and unwanted vegetation.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.	Same as Alternative B.

Comparing the Human Health Dimension of the Alternatives

Each of the alternatives has a potential for impacts on the health of both forest workers and the general public. The risk of health impacts is greater for forest workers because they are subjected to repeated and more direct exposure to risk-causing factors. Health risks to the general public are through indirect exposures to herbicides or smoke that have been carried away from a project area by wind or water.

For this analysis, risks and effects are estimated only for those activities directly associated with vegetation management. The comparison includes analysis of:

- accidents from manual control of vegetation and brush;
- accidents from the management and control of prescribed and wildfires;
- health effects from exposure to smoke from prescribed and wild fires; and
- health effects from exposure to herbicides used to manage vegetation.

The analysis does not include risks from activities that are incidental to vegetation management, such as transportation to job sites, and exposure to gasoline, exhaust fumes, and noise from engines (chain saws, tractors, helicopters, etc.). Although the risks from these exposures are real, there are far too many to cover them adequately in this analysis.

Comparison of Risks Between Alternatives

The number of acres that would be treated by each method of vegetation management varies between alternatives (Table II-1). These

Table II-1

Acres Treated¹

(by vegetation management methods and alternatives)

Alternative	A	B	C	D	E	F	G
<i>Method</i>							
Prescribed Fire	218	210	0	126	194	176	215
Wildfire	16	16	25	21	16	18	17
Manual	99	78	18	58	95	80	86
Herbicide (Total)	0	60	0	27	48	64	77
Herbicide (Aerial ²)	0	30	0	14	0	32	39

¹Sources: Figure II-10 and Figure IV-2.

²Aerial application estimated to account for 50 percent of total acres to be treated with herbicides, except for Alternatives C and E, where no aerial application is allowed.

estimates of acres can be used to calculate comparisons between alternatives.

Comparisons that can be made by alternative using the acres treated in Table II-1 include 1) estimated number of worker accidents, and 2) risk to workers and public from herbicides and smoke.

Only forest workers, and not the public, are expected to be at risk from immediate injury due to accidents. The risk of injury occurs primarily with the use of manual methods or prescribed fire on rough terrain. The difference in risks between alternatives can simply be estimated from the total numbers of acres that receive manual or fire treatment in an alternative.

In this analysis, the number of injuries is estimated as follows. Minor injuries are expected to occur in prescribed fire treatments at the rate of two for every 1,000 acres treated. For manual methods, the estimated rate is 7.7 per 1,000 acres treated. For major injuries, the estimates are made only for prescribed fire treatments and are expected to occur at the rate of 0.13 per 1,000 acres treated. Injuries from wildfire are estimated in the same way as for prescribed fire, as no separate rate estimates are available.

Using the acre estimates from Table II-1 and the accident rates discussed above, the risks from using manual methods and prescribed fire can be compared between alternatives (Table II-2).

Table II-2

Anticipated Number of Worker Accidents Per Year

(from use of manual methods and prescribed burning, by alternative)

<i>Alternative</i>	A	B	C	D	E	F	G
Worker Accidents							
Minor	1,230	1,053	189	741	1,152	1,004	1,126
Major	30	29	3	19	27	25	30

There are risks to both forest workers and the general public from exposure to herbicides and smoke. The difference in risks can be determined by comparing the numbers of acres in each alternative that would be treated with herbicides, or burned by prescribed or wildfire. The analysis does not try to estimate the actual number of people that might be affected by these exposures, because it would have to rely on too many disputed assumptions.

For both workers and the public, there is no convincing evidence that exposure to herbicides is more or less hazardous than

Worker Accidents

Risks From Herbicides and Smoke

exposure to smoke. Therefore, the risks for both of these exposures are compared by estimating the total number of acres that would be treated either by herbicides or fire in any alternative, with one exception. For the public, aerial application of herbicides presents more risk than ground application. Therefore, risk indices for the public (Table II-3) were estimated using only those acres treated by aerial application of herbicides, and total acres treated by fire.

Table II-3

Comparing Risk Indices From Exposure to Herbicides and Smoke¹
(between alternatives)

Alternative	A	B	C	D	E	F	G
Worker	266	318	75	216	290	294	343
Public	266	288	75	203	242	262	305

¹Because wildfires are more intense than prescribed fire, the number of acres burned by wildfire is multiplied by three before adding to the total of acres treated by fire and herbicide. Material burned in wildfires can release about three times the amount of smoke per acre as prescribed fires.

For both the workers and the public, this method of comparing risks has its limits. It should not be used to compare the risks to workers with those to the public. Forest workers receive far more frequent and higher exposures than do members of the general public, and the acre totals do not reflect that difference between the two groups (Table II-3).

Another way to see the differences between the alternatives is to look at their percent change from Alternative C, the “no action” alternative. Although Alternative C is not without risk, it presents the lowest risk because it would result in the fewest acres treated. This makes the alternative a good reference for comparison.

For worker accidents, all the alternatives show a much higher percentage of risk, compared to Alternative C (Figure II-4).

For risks associated with herbicides and smoke, all the alternatives again reflect a much higher percentage than does Alternative C (Figure II-5).

Excluding the reference alternative (C), Alternative D stands out as the least risky alternative for all effects by a considerable margin. For all injury accidents, Alternative D represents an estimated reduction of 26 percent compared to the next least risky alternative, and a reduction of 40 percent over the most risky alternative. Thus, risks for all other alternatives fall in a range of only 14 percent.

Similar patterns are seen for both worker and public risks

Figure II-4

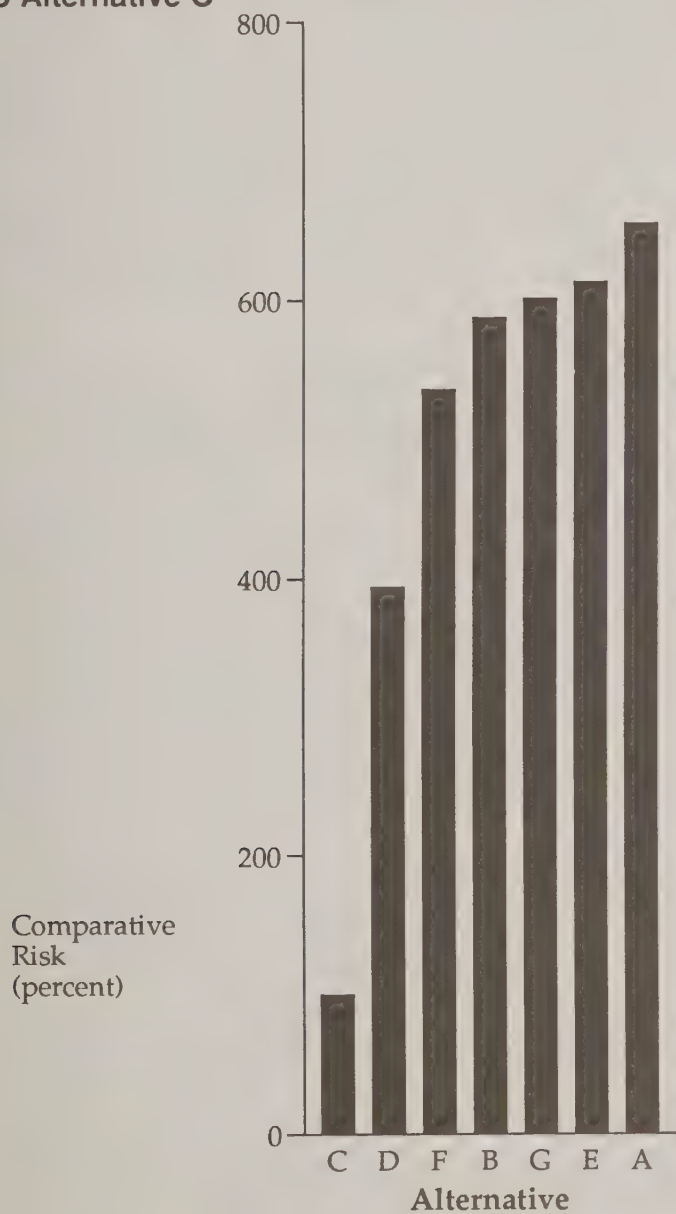
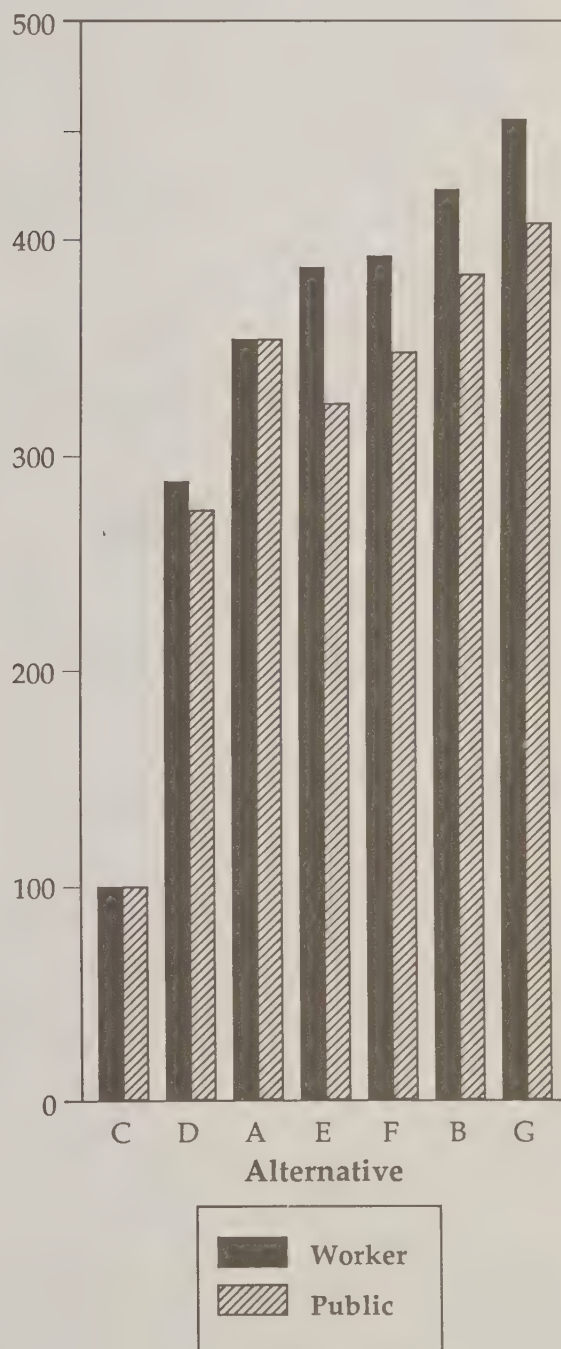
Worker Injury Accident Risk Compared to Alternative C

Figure II-5

Comparison Index for Risks From Exposure to Herbicides and Fire Smoke

associated with exposures to herbicides and smoke. For forest workers, risks estimated for Alternative D are 19 percent lower than the next least risky alternative, and 37 percent lower than the most risky alternative. For the general public, risks estimated for Alternative D represent a reduction of 16 percent compared to the next least risky alternative, and 33 percent compared to the most risky alternative.

All the other alternatives vary in their risk by effect within a fairly limited range. Alternative G ranks highest for risks associated with exposures to herbicides and smoke, and third most risky for risks of injury due to accidents.

Comparing the Public Participation Dimensions of the Alternatives

All alternatives (A—G) emphasize and assure the involvement of interested members of the public in vegetation management decision-making processes, especially project level planning. Public participation needs will be reviewed during scoping efforts, as an integral part of environmental analysis. Options for involving potentially interested and affected individuals, organizations, and governments in the analysis process will be identified.

NEPA guidelines as implemented in the Council of Environmental Quality Regulations (40 CFR Parts 1500-1508), Forest Service Manual 1950, and Forest Service Handbook 1909.15 will be followed. These include:

“an early and open process for determining the scope of issues”; and

“invite[ing] participation of affected Federal, State and local agencies, Indian tribes, proponents and other interested persons” (40 CFR 1501.7).

In addition, the regulations require agencies to:

“make diligent efforts to involve the public in preparing and implementing their NEPA procedures...provide public notice...hold or sponsor public hearings or public meetings whenever appropriate...solicit appropriate information from the public...explain procedures where interested persons can get information...[and] make environmental impact statements, comments, [and] underlying documents available to the public” (40 CFR, 1505.6).

Alternative D places increased emphasis on early involvement of members of the public in environmental analysis procedures, and on carrying this participation through to project implementation and monitoring. Under this alternative, public involvement may occur more frequently and for a longer period of time than for the other alternatives.

In Alternative C, public involvement will occur infrequently, because there is no management of vegetation (unless public health and safety is threatened). If a vegetation management project is proposed, NEPA guidelines as stated above will guide public involvement efforts.

Comparing the Social and Economic Dimensions of the Alternatives

The principal social effects of these alternatives occur as a result of the changes that occur in the economy. Changes will be most pronounced in southwest Oregon. Table II-4 shows how the respective alternatives are expected to affect the number of jobs in Oregon and Washington over the coming decade.

Table II-4
Changes in Jobs in Oregon and Washington by Alternative

Alternative A	-1,100
Alternative B	Reference*
Alternative C	-21,000
Alternative D	-3,100
Alternative E	-1,400
Alternative F	-3,100
Alternative G	+2,600

Information generated using the IMPLAN local economic impact model described in Appendix B. "Jobs" includes permanent and temporary positions, part-time and full-time positions, without discrimination. Figures shown represent average annual conditions over the coming decade.

*The reference is the expected situation with implementation of the Forest Plans currently being developed.

Table II-5 shows how the various alternatives would affect personal income in the states of Oregon and Washington. As in the case of the "jobs" information presented above, the great bulk of the effects are caused by anticipated changes in the timber harvest level.

Table II-5

Changes In Personal Income in Oregon and Washington by Alternative [(1987) million dollars].

Alternative A	-28
Alternative B	Reference*
Alternative C	-533
Alternative D	-76
Alternative E	-33
Alternative F	-75
Alternative G	+63

Information generated using the IMPLAN local economic impact model described in Appendix B. Figures shown represent average annual conditions over the coming decade.

**The reference is the expected situation with implementation of the Forest Plans currently being developed.*

Table II-6 shows what would be expected to happen to payments to local governments under the various alternatives. Unlike jobs and personal income information presented above, no payments to local governments result directly from vegetation management practices covered in this EIS.

Table II-6

Changes In Average Annual Payments to Local Governments

Alternative A	- \$ 4,900,000
Alternative B	Reference*
Alternative C	- \$57,100,000
Alternative D	- \$ 7,400,000
Alternative E	- \$ 4,300,000
Alternative F	- \$ 8,400,000
Alternative G	+ \$ 2,600,000

**The reference is the expected situation, first decade of implementation of the Forest Plans currently being developed.*

As indicated in Chapter IV, the changes seen in the alternatives (except for Alternative C) are well within the usual year-to-year variations in employment, income, and payments seen in the Pacific Northwest. This variations arises in large part from variation in timber harvest levels, which are in turn dependent on the level of housing starts and other economic indicators in the national economy.

The community effects of Alternatives A, D, E, and F are not

positive ones. They are however, on average, significantly less disruptive than the economic fluctuations experienced in the region's communities over the last ten years, and would be difficult to distinguish from other effects.

Alternative G would contribute through slightly enhanced economic activity, but this change is again minor compared to the usual year-to-year changes.

Alternative C would significantly disrupt normal economic activity in the region, and would have disruptive social and health effects on some of the region's communities.

Comparing the Cost/Benefit Dimension of the Alternatives

A cost-benefit analysis is relevant to the choices among alternatives of this environmental impact statement, and has been used as an aid in evaluating environmental consequences. To better understand the comparison of the alternatives on the cost/benefit dimension, a short background section introduces the general approach of the economic analysis. The actual comparison of alternatives follows.

The cost-benefit analysis considers all significant dollar-quantified costs and benefits that relate (directly or indirectly) to vegetation management practices. It includes all those dollar-quantified costs and benefits (both short-term and long-term) which are expected to be significantly affected by the vegetation management alternatives.

Our approach recognizes costs and benefits as they are expressed in dollar terms in the marketplace. Identified costs and benefits which have not been dollar-quantified are discussed in narrative terms.

Future costs and benefits are different from those that exist today.

The future costs and benefits are converted to today's terms through discounting. That is, a benefit (or cost) occurring today is counted at its full value, while a future benefit (or cost) is discounted using a four percent real discount rate. A discounted future value is called a "present value."

A sensitivity test is done to show the decisionmaker how the economic efficiency information would be affected by a different real discount rate.

Background

$PVB - PVC = PNV$ where,

PVB is the present value of the benefits

PVC is the present value of the costs

PNV is the present net value

The alternative with the greatest economic efficiency is the alternative with the highest PNV.

The economic assumptions and definitions used in this analysis are consistent with those currently in use in this Region for Forest planning.

The period of the analysis is one hundred years, and a four percent real discount rate is used. (Forest Service Manual 1971.71). A one percent annual real price increase in stumpage values is assumed to occur over the next fifty years. No real cost changes have been estimated. Stumpage and livestock forage are the benefits tracked in dollar terms. Dollar-quantified costs are the National Forest costs associated directly or indirectly with vegetation management. Permit-tee costs associated with livestock management tracked by the Forest Service are also included in the analysis.

Comparison of Alternatives

The primary driver in the economic analysis was the costs and benefits associated with the timber program—the management of the timber resource. Costs and benefits of the range program were also tracked in the economic model, as were other costs associated with vegetation management. Even in aggregate, these other costs were clearly secondary to those associated with the timber program.

Discussion with Region- and Forest-level personnel disclosed no real concern that any of the alternatives would significantly affect other dollar-quantifiable outputs such as recreation visits, mineral outputs, water quality, or water quantity. Some people do feel that their recreational experience, for instance, would be affected—either quantitatively or qualitatively—by the character of the alternative finally selected. Certainly some individuals could experience a sense of loss if unwanted vegetation in one of their favorite recreation areas were to be treated in a manner which was distasteful to them. Generally though, the periods of the treatments are short, and scheduled in such a way as to minimize conflicts with recreational users.

The salient characteristic of the analysis is that changes in vegetation management are expected to result in changes in the Region's overall level of timber offerings from what would otherwise be possible in any alternative. (An allowable sale quantity of from 3.8 to 4.3 billion board feet annually is expected under Alternative B.) To some extent this conclusion is speculative, as volume lost on one Forest may be made up by increasing the volume harvested on another.

Based on the characteristics of the timber inventory of each National Forest, the change in timber sale offerings may be immediate, or may only come about in the distant future. The question is complicated by the fact that Forests in the Region are considering a wide range of timber harvest levels, as well as alternative harvest schedules for that harvest.

During the construction of the alternatives, every attempt was made to make the alternatives as realistic as possible. We did not expect the Forest Service to throw money at a problem, wasting it in pursuit of a goal which no longer appeared realistic. For instance, forcing 100 percent achievement of a timber goal would have made some alternatives tremendously costly. The more realistic approach was to strive to meet the target with some increase in unit and total costs.

Viewed from a total budget perspective, costs associated with vegetation management are quite small. Substantial changes could occur in the vegetation management component of some individual budget line items that would go almost without notice at the level of the overall budget.

The impacts of such changes are felt when they result in changes in the timber program. A shift in the allowable sale quantity for a Forest affects its entire budget because the timber program funds much of the engineering, protection (fire), and other program activity at the Forest level. Thus, small changes in vegetation management practices can translate into much larger cost and benefit changes.

Table II-7

Change in Economic Efficiency by Alternative
[4 percent discount rate, in (1987) million dollars]

Alternative	A	B	C	D	E	F	G
Present Value of the Benefits (PVB)	-484	REF.	-7,326	-879	-290	-852	+525
Present Value of the Costs (PVC)	-16	REF.	-3,499	-633	-158	-531	+501
Present Net Value (PNV)	-468	REF.	-3,877	-246	-132	-322	+ 24

See the economic analysis appendix for additional information about the analysis leading to this table.

REF. stands for reference. It indicates the situation expected with implementation of the Forest Plans currently being developed.

The great bulk of the cost information contained in Table II-7 (previous page) is not associated directly with vegetation management. None of the benefit information is directly related to vegetation management since the benefits of vegetation management are tracked in other Forest outputs such as timber offerings. Vegetation management is an activity rather than an output.

As shown in Table II-7, Alternative G has the highest present net value (PNV) of any alternative considered. Alternative G allows the greatest level of flexibility in managing competing vegetation. Alternative B was a close second. Basically this means that the Forest Service could move to Alternative G and come out better in terms of net dollar-quantified benefits.

A decision to select an alternative with a lower PNV means that the decisionmaker has decided that the net benefits not counted in dollars more than make up the loss in net benefits which are expressed in dollars.

Alternative E also scores high in economic efficiency. The net economic effect of the additional restrictions it imposes is quite small. Much of the decrease shown in the present value of the costs (PVC) comes about as a result of an anticipated decline in Forest timber offerings. A relatively small part is savings from decreased treatments. Other treatment costs actually increase because of the additional constraints on tools and operating procedures.

In the center of the array of alternatives (in terms of present net value) is Alternative D. Its costs decline because a small decline in timber production is anticipated, and because treatment of potential problem areas is deferred until evidence is more complete that treatment really is necessary.

Alternative F sharply restricts the use of fire as a tool for managing competing and otherwise unwanted vegetation. Fire is commonly used in support of many Forest programs. In some instances there is no other cost-effective substitute presently known. If the tool is not available, the work simply will not be done. For instance, under this alternative, there will be an increase in acreage burned by wildfires, because many acres of slash would not be treated.

Alternative A has the next to lowest present net value. The exclusion of herbicides and the substitution of more costly measures causes a significant decrease in PNV. Use of more costly measures prevents a greater loss in the timber program than would otherwise have been the case, but their use is not sufficient to prevent a significant reduction in timber sale offerings.

Because no vegetation management is done, Alternative C has the lowest PNV ranking. The restrictions in this alternative are so

severe that massive reductions in Regional timber sale offerings would be needed. That generates sharp decreases in both benefits and costs.

Table II-8 uses the same input data as was used for Table II-7 but has its output calculated at a 7-1/8 percent discount rate (as required by FSM 1971.71) to enable the decisionmaker to see the effects of such a change.

Table II-8

Change in Economic Efficiency by Alternative
[7-1/8 percent discount rate, in (1987) million dollars]

<i>Alternative</i>	A	B	C	D	E	F	G
<i>Present Value of the Benefits (PVB)</i>	-280	REF.	-4,199	-506	-189	-489	+298
<i>Present Value of the Costs (PVC)</i>	-4	REF.	-2,009	-387	-121	-325	+318
<i>Present Net Value (PNV)</i>	-277	REF.	-2,190	-119	- 68	-164	+ 20

See the economic analysis appendix for additional information about the analysis leading to this table.

REF. stands for reference. It indicates the situation expected with implementation of the Forest Plans currently being developed.

The alternatives require different levels of funding for the Forest Service to implement them. These levels appear in Table II-9. The budget figures show the combined effects resulting from changes in timber harvest levels, changes in the level of permitted livestock grazing, and the changes in vegetation management practices. The rankings by budget are very similar to the expected harvest level rankings. Some small shifts do occur due to the mix of vegetation management practices in each alternative.

Forest Service Budgets

Table II-9

Estimated Change in Annual Forest Service Budgets
[In (1987) million dollars]

<i>Alternative</i>	A	B	C	D	E	F	G
<i>Change in Budget</i>	+1	REF.	-126	-21	-9	-19	+20

See discussion in economic analysis appendix for additional information.

REF. stands for reference. It indicates the situation expected with implementation of the Forest Plans currently being developed.

Comparing the Environmental Effects Dimension of the Alternatives

Environmental Effects

Each of the alternatives has the potential to affect physical and biological components of the environment, such as air quality, water quality and quantity, soil, vegetation species and diversity, and fish and wildlife. All of these environmental components are interrelated, so that changes in one component may cause changes in others. See Chapter IV, Environmental Consequences, for a complete discussion of possible direct and indirect effects of vegetation management activities on these components of the environment.

All alternatives would employ the same mitigation measures governing implementation of a particular method or technique for management of competing or unwanted vegetation. The mitigation measures are listed in Chapter II following a description of each of the methods. For example, on a given site where mechanical methods are employed, all of the alternatives would limit tractors to slopes of less than 35 percent, and limit these operations to conditions that minimize the potential for compaction.

The alternatives do vary in the extent of treatment and methods available. Therefore, for alternatives that allow more acres to be treated with methods having a potential for adverse impacts (on any given resource), there is a higher risk of adverse impacts occurring. For example, alternatives involving extensive use of prescribed burning would have a higher risk of impacting air quality than those that minimize the number of acres burned.

Effects on Soil, Water, Long-term Productivity, and Air

The potential for effects on soil, water, long-term productivity and air quality varies between alternatives. Mechanical and biological methods of vegetation management, as well as use of herbicides and prescribed burning, may affect these resources.

For manual methods, there is a lower potential for impacts—and less variation (between alternatives) in acres treated than for any other method available. Table II-10 displays the acres likely to be treated each year under each of the alternatives.

Effects on air quality are related to the amount of prescribed burning that would occur under each alternative. These effects can be estimated using the the total suspended particulates produced by the use of prescribed fire under each of the alternatives (Table II-11). All of the

Table II-10

Acres Treated Using Methods Having Potential Impacts on Physical and Biological Resources
(in thousands)

<i>Alternative</i>	A	B	C	D	E	F	G
<i>Method</i>							
Herbicides	0	60	0	27	48	64	77
Mechanical¹	168	161	36	104	158	193	147
Biological	15	4	4	19	6	8	7
Burning	218	210	0	126	194	176	215
Total	401	435	40	276	406	441	446

¹Does not include roadside and mechanical brushing for rights-of-way.

Table II-11

Average Annual Production of Suspended Particulates Less than 2.5 Microns in Diameter Produced by Prescribed Fire
(In tons per year)

<i>Alternative</i>	A	B	C	D	E	F	G
Tons of suspended particulates less than 2.5 microns in diameter per year	37	37	0	22	33	24	38

alternatives meet the objectives of the State Implementation Plans and the State Smoke Management Plans of Washington and Oregon.

Wildfires also have an effect on air quality that must be considered. For some alternatives, prescribed fire may have a minimal impact on air quality, while wildfire may have a greater impact.

The buildup of natural and activity fuels increases wildfire hazard. High intensity wildfires could result in damage to soils, water quality, and in reduced long-term productivity of the land. However, it takes several decades for fuels to accumulate, and for these effects to be manifested. Therefore, wildfire hazard is displayed as the number of acres expected to burn in the fifth decade after implementation of an alternative.

The following discussion compares the alternatives in increasing order of potential effects on soil, water, and air resources, and long-term productivity.

Table II-12

Expected Average Number of Acres Burned Annually by Wildfire
(In the fifth decade, in thousands of acres)

<i>Alternative</i>	A	B	C	D	E	F	G
Thousand acres burned by wildfire, per year (fifth decade)	13	13	41	25	19	22	14

Alternative C, the “no action” option, would manage the fewest acres of competing and unwanted vegetation. There would be no risk of contamination of soil or water resources from herbicides. There would also be no risk of adverse effects on air quality or long-term productivity from use of fire as a management tool. Adverse effects on soil and water from mechanical methods of vegetation management would be minimized. However, Alternative C would result in the greatest wildfire hazard of any alternative.

Alternative D would result in the fewest acres treated of any of the action alternatives, due to the prevention philosophy of this alternative. There would be some risk of contamination of soil and water resources by herbicides, but it is low compared to other alternatives which include use of herbicides. There would also be a low potential for adverse impacts on air, soil, and water resources from prescribed burning. However, Alternative D is predicted to have the highest future (fifth decade) wildfire hazard of the action alternatives (excluding Alternative C). This alternative also involves the fewest acres mechanically treated, with low risk of impacts on the soil and long-term productivity. Alternative D would involve the most acres treated with biological methods of vegetation management. This could result in positive or adverse impacts on a site, depending on site conditions and the technique employed.

Alternative A prohibits the use of herbicides, with a resulting increase in use of mechanical, biological, and prescribed fire methods. While total acres treated is 1.5 times greater than Alternative D, it is less than the other action alternatives. Alternative A involves a moderately high acreage treated using mechanical methods and prescribed burning, and a significantly higher risk of adverse impacts on air, soil, and water resources as compared to Alternative D. Therefore, the potential for an adverse impact on long-term productivity is also higher. However, Alternative A is predicted to result in 50 percent fewer acres burned by wildfire in the fifth decade as compared to Alternative D.

Alternative E would not involve aerial spraying of herbicides and would prohibit use of certain “high risk” herbicides. While nearly

twice as many acres would be treated with herbicides as Alternative D, the closer control obtained by backpack and truck-mounted sprayers would reduce the risk of water contamination. However, the potential for adverse impacts on soils and long-term productivity would be higher than Alternative D due to the increased acreage treated using mechanical methods and prescribed burning. Compared to the other action alternatives, Alternative E has a medium risk of potential impacts on air, soil, and water resources. Wildfire hazard in the fifth decade is slightly higher than under Alternative A, but significantly lower than Alternative D.

Alternative F would result in a reduction of acres treated by prescribed burning for reduction of activity fuels (logging slash), but would still result in a higher use of burning than Alternative D. Future wildfire hazard is fairly high as compared to the other alternatives. Alternative F also involves an extensive use of mechanical methods, and overall a high total number of acres treated. This would lead to a higher risk of adverse impacts on soil, water quality, and long-term productivity than most of the other alternatives. Risk of soil and water contamination from herbicides is also fairly high, compared to the other alternatives.

Alternative B is similar to Alternative F in overall acres treated and use of herbicides. Fewer acres would be treated using mechanical methods, but more acres would be treated by prescribed burning than Alternative F. This would result in a higher potential for immediate impacts on air quality, but much lower wildfire hazard in the future. The potential for impacts on soil, water, and long-term productivity is similar to that under Alternative F.

Alternatives G involves extensive use of prescribed burning and herbicides, and slightly lower use of mechanical and biological methods than the other action alternatives. This alternative poses the highest risk of soil and water contamination from herbicides. Alternative G would result in the highest emission of total suspended particulates each year, but a low wildfire hazard in the future. Risk of adverse impacts to soil, water and long-term productivity is relatively high from extensive use of fire as a management tool. However, the relatively low number of acres of mechanical treatment would reduce the risk of adverse impacts on soil and water from the use of this method as compared to the other alternatives.

Each of the Forests in the Region has developed management guidelines for riparian areas based on local conditions. Although vegetation management activities may affect riparian vegetation, there will not be a significant variation among alternatives in effects on riparian vegetation. Since fish habitat largely depends on the condition of the adjacent

Effects on Riparian Areas, Fish, and Threatened and Endangered Species

riparian area, there will not be a significant variation in effects on the fisheries resource between the alternatives. All of the alternatives will protect threatened and endangered species in accordance with the Endangered Species Act, and with direction found in Forest Service Manual 2670.

Effects on Diversity

All alternatives will have similar impacts on vegetation diversity within the Region. Existing laws as well as the mitigation measures governing implementation of each method will determine the impact of management of competing and unwanted vegetation on diversity. However, Alternative C, with the higher hazard of extensive, intense wildfire, has the greatest potential for affecting vegetation diversity.

Effects on Wildlife

There is a low probability that any of the alternatives considered will result in a significant adverse impact to the viability of any wildlife population in the Pacific Northwest Region.

Alternative C creates the highest long-term risk because it limits vegetation management opportunities for improving or maintaining habitat suitability, while increasing the risk of catastrophic wildfires in the future.

Alternatives B, F, and G have the highest potential for impact on wildlife populations at the project level, because, under all three, a higher number of acres are managed intensively, using all available methods in "preventive" and "corrective" strategies.

These two strategies are also used in Alternative A, which has a program similar in size to Alternatives B, F, and G. However, the restriction on use of herbicides in Alternative A reduces the risks to wildlife populations. This risk is associated with the lack of detailed study on the indirect and cumulative effects of herbicides on the numerous wildlife species that could potentially be affected.

Alternative D proposes a significantly smaller program and emphasizes a preventive rather than corrective strategy. Preventive strategies are usually implemented early and provide many opportunities to mitigate potential adverse consequences. Corrective measures tend to be more disruptive to wildlife habitat.

Comparing the Effectiveness of Techniques Dimension of the Alternatives

The issue area looks at the ability of forest managers to fit vegetation management tools to the appropriate site conditions, given the constraints of each alternative.

The success of any treatment is measured by how well the prescription or management objectives are met. For example, a silvicultural treatment is often evaluated against standards for seedling survival and vigor following the reduction of competing vegetation. The anticipated conifer growth response can be measured against predetermined standards for plantation development. A common objective in roadside maintenance may be an improved line-of-sight for motorists. Management goals are defined prior to treatment in order to establish measurable standards for the monitoring of results.

Any treatment method will be successful when applied in the proper set of site-specific circumstances and performance levels.

In Table II-13, the relative effectiveness of vegetation management under each alternative is displayed, using a scale of 1 (ineffective) to 10 (highly effective).

Table II-13
Relative Effectiveness of Vegetation Management

Alternative	A	B	C	D	E	F	G
Relative Effectiveness	8	10	1	9	8	8	10

key: 1 = ineffective
10 = highly effective

Much of the background for this section is found in the appendices. Appendix E (Silviculture Program Effects for Site Preparation and Release) includes examples of the successful use of methods within some specific operational and biological limitations. Appendix C (Herbicide Use and Efficacy) describes the relative effectiveness of chemicals and some typical target vegetation. Appendix A (Timber Growth and Yield) evaluates some specific situations in which treatment effectiveness is reduced due to operational or environmental factors.

Alternative A The suspension of the use of herbicides will result in reduced treatment effectiveness in a few silvicultural situations. This is primarily due to reduced duration of vegetation control when target vegetation has the potential for aggressive site reoccupancy. For example, on the average (Region-wide), it has taken an estimated 1.8 manual cuttings—compared to 1.1 herbicide treatments—to adequately meet prescription release objectives.

Reduced treatment effectiveness will be most apparent when dealing with sclerophyllous species, such as with stands containing a well established tanoak or madrone component. Certain other woody shrubs and herbaceous species will also present some difficult problems in the absence of the use of herbicides (see Appendix A).

A reduction in treatment effectiveness in these vegetative conditions will translate into tree mortality and growth loss in managed young timber stands. The estimated reductions in long-term sustained yields shown in Appendix A are:

Vegetation Complex	Yield Reduction
Ponderosa pine/shrub/herbaceous	4%
Conifer/Ceanothus spp./herbaceous	5%
Douglas-fir/tanoak-madrone	19%
True fir-hemlock/shrub/herbaceous	7%

Region-wide, this growth effect could eventually result in a modest reduction in harvest levels of approximately 2-1/2 to 3 percent, or 95 to 125 million board feet annually. While these potential harvest level effects are relatively small, the impact will tend to be concentrated on National Forests in the southern Cascades and Transition subregions.

Likewise, there will be reduced effectiveness of treatment in certain roadside maintenance and noxious weed control situations. Region-wide, this effect will be relatively minor, but it may be significant at the Forest level.

Alternative B This alternative is used as a reference for the evaluation of other alternatives. All tools and techniques are available for use in the appropriate environmental setting. This is expected to translate into optimum effectiveness for operational vegetation management programs.

Timber harvest levels (allowable sale quantity) are anticipated to be approximately 3.8 to 4.3 billion board feet annually, following implementation of Forest land management plans. This alternative also allows the management flexibility to assure treatment effectiveness in programs such as right-of-way maintenance, range improvements, and noxious weed control.

Only that vegetation management necessary to meet legal obligations in the area of human health and safety will occur under this alternative. On most Forests, this would involve a limited amount of roadside vegetation control. Timber yields would be reduced by an estimated 25 to 50 percent (see Appendix A), as severe stocking losses and early growth effects occur.

The following eventual decrease in timber yield is anticipated:

Vegetation Complex	Yield Reduction
Douglas-fir/alder	25%
Douglas-fir-hemlock/salmonberry	21%
Ponderosa pine/shrub/herbaceous	52%
Conifer/Ceanothus spp./herbaceous	39%
Douglas-fir/tanoak-madrone	65%
True fir-hemlock/shrub/herbaceous	46%

The greatly reduced success of the reforestation program would trigger major changes in the timberlands “suitability” classifications made in the Forest Land Management planning process.

All methods are available under this alternative, although added caution and reduced tolerance for data gaps and uncertainty will translate into reduced program accomplishment in the short-term.

For example, estimates from the 19 Forests indicate that 12 percent of the silvicultural diagnoses would result in a no-treatment or deferred action decision under Alternative B. Under Alternative D, however, an estimated 26 percent of these prescriptions would be a deferred or “no action” decision (see Appendix E). This means that roughly an additional 15,000 acres per year will be left untreated.

As knowledge is gained through the increased emphasis on research and monitoring, the vegetation management programs will tend to become more effective and efficient.

In the short-term, however, the Forests anticipate a modest reduction in timber yields as a result of the deferred action under this scheme of management. This potential yield reduction is estimated to be 1-1/2 to 2 percent per year (approximately 55 to 85 million board feet).

An emphasis on preventive measures should improve the effectiveness of treatments over time as the need for subsequent corrective action is reduced. Management emphasis under this alternative also tends to encourage more creativity in dealing with site-specific problems.

Aerial herbicide application is discontinued, and manual cutting will become more restricted under this alternative. Four herbicides—2,4-D,

Alternative C

Alternative D

Alternative E

Amitole, Diuron, and Fosamine—will not be used. The use of Bromacil, 2,4-DP, and Simazine will also be limited under this alternative.

Effectiveness of vegetation control will be reduced on steep terrain, and on sites occupied by tall or dense competing vegetation. The Forests also indicate that a slight increase in deferred action and no-treatment decisions will occur in comparison with Alternative B (approximately 1,000 additional acres per year).

In general, however, the substitution of methods under this management scheme will maintain a generally high level of program effectiveness. The estimated potential decrease in timber yields is 1 to 1-1/2 percent (approximately 35 to 65 million board feet).

Some reduced treatment effectiveness will be seen in the roadside maintenance program because the herbicides amitrole, 2,4-D, diuron, and fosamine are no longer available for application. Region-wide, the effect will be relatively minor, although the cost of doing business will increase.

Alternative F

The elimination of prescribed fire as a site preparation tool is the principal program effect under this alternative. The limitation on broadcast burning will also restrict some rangeland rehabilitation efforts in the East-side subregion.

In certain situations, the suspension of controlled burning will have a negative effect on reforestation success. This will occur primarily where concentrations of brush or logging residues create physical obstructions to reforestation. The result in these cases will be more non-stocked and understocked inclusions within managed stands. In extreme situations, adjustments in the "suitable timberlands" classification may result. The Forests have estimated that 2-1/2 to 3 percent of the suitable landbase will be affected. This represents approximately 95 to 125 million board feet annually in reduced timber yields.

Substitution of other methods for fire use, and more aggressive yarding of non-merchantable material during logging, will maintain treatment effectiveness at satisfactory levels in the great majority of situations. Appendix E contains an assessment of reforestation success in the absence of prescribed fire. Forests in the Coastal and southern Cascades subregions will tend to be most affected by this alternative.

Alternative G

The enlarged program of work is the principal factor related to treatment effectiveness under this alternative.

As in Alternative B, all techniques are freely available. For example, there is a 12 percent increase in cultural treatments in comparison with other alternatives. The Forests have estimated that this intensified management will eventually translate into a 2-1/2 to 3

percent increase in timber yields (approximately 95 to 125 million board feet per year).

An improved tree per acre stocking level in some difficult reforestation conditions is the primary beneficial effect seen under this alternative. The more aggressive management scheme will also present opportunities to enhance the effectiveness of certain right-of-way, rangeland improvement, and noxious weed control efforts.

Most of the intensified management effort, however, will occur on lands that are considered only marginally suitable for regulated timber harvest. This will often mean that some cost efficiency is sacrificed, and the risk of adverse effects related to site productivity increases. A typical example may be the conversion of some non-commercial hardwood stands growing on sites with skeletal or poorly developed soil profiles in the southern Cascades.

Comparison of the Interagency Coordination Dimension of the Alternatives

In all alternatives, coordination with federal, state and local agencies is emphasized and assured. National Environmental Policy Act (NEPA) guidelines as implemented in the Council of Environmental Quality Regulations (40 CFR, Parts 1500-1508), Forest Service Manual 1950, and Forest Service Handbook 1909.15 will be followed.

This includes establishing cooperating agencies where appropriate in the analysis process, and including affected agencies in all public participation efforts. For vegetation management projects, key agencies include state and federal natural resource agencies, state departments of transportation and agriculture, and appropriate health agencies. Contacts with local offices of these agencies and other independent local agencies is especially important in project-level planning.

Under Alternatives A and C (which prohibit use of chemical herbicides), there may be a need for increased coordination between the Forest Service, state departments of agriculture, and county weed boards in managing noxious weed populations.

2 The Alternatives

Chapter 2
The Alternatives

Alternatives
Considered
but Eliminated

Implementing
the Alternatives

Alternatives Considered but Eliminated From Detailed Study

This section of the EIS describes alternatives that were suggested and considered, but not studied by the interdisciplinary team as fully as the final seven alternatives. There is also an explanation as to what was learned from studying these other alternatives before eliminating them.

The Oregon Legislature was, during the writing of this EIS, considering legislation to aid in the abatement of air pollution caused by open burning (including the burning of logging slash). Consideration was given to building and analyzing alternatives that would specifically examine how the Forest Service would conduct its programs in light of that potential legislation. However, the specific provisions of the law are not yet apparent, and such an alternative concerning it would be highly speculative.

All seven alternatives that were considered in detail do address the effects of various levels of prescribed burning on air quality. All alternatives have levels of prescribed burning that will meet the State Implementation Plan goals for total suspended particulates (TSP) by the year 2000.

Three alternatives reduce the use of prescribed burning. Alternative C prohibits all use of prescribed fire for vegetation management; Alternative F explicitly forbids the use of fire for site preparation work; and Alternative D uses less fire because its preventive techniques are expected to reduce vegetation management problems.

The data base and the model used in analyzing fire and air pollution effects of the alternatives will continue to be available for analyzing the effects of any new programs, legislative or otherwise.

This alternative would have stressed the use of labor-intensive practices in managing vegetation. The alternative was not developed, as initial analysis showed that it would require larger budgets than could be reasonably expected.

The alternatives do cover a substantial range of job levels. Alternative G does explore enhanced employment through increased commodity production. Alternatives which prohibit herbicides (A and C) both would result in a net decrease in employment.

A vegetation management alternative designed specifically to

**Alternative
Responding to
Oregon Air
Quality
Legislation**

**Maximize
Employment**

address the needs of the unemployed is considerably outside the scope of this EIS. As a "jobs program," it would be more normally developed in legislative programs.

Employment generated by vegetation management activities is quite small relative to the overall level of employment generated in the Pacific Northwest from Forest Service programs and activities.

Initial analysis showed a high-production, labor-intensive alternative would require a very high level of additional funding. Given the concerns that the alternatives needed to be as economically efficient as possible, and within probable budgets, the interdisciplinary team eliminated this alternative from detailed study.

Budget and Output Emphasis Alternatives

During the formulation of alternatives, concern arose that the descriptions of alternatives A, D, E, and F were not sufficient for an adequate understanding of their management implications and environmental consequences.

The specific question was whether commodity outputs or operating budgets would have precedence when estimating what the vegetation management program would be like. (Forests operate within a budget, and have expected levels of work activities to perform. These result in expected levels of commodity production, also called "outputs.")

Vegetation management methods vary in their economic efficiency—some cost more for the same result. Specialists on the National Forests could estimate the management implications of the alternatives in two ways—they could assume that extra budget funds would be available in order to produce the expected outputs; or they could reduce expected level of outputs when less efficient methods of vegetation management absorbed all the budget funds for it.

Some increases in budgets could reasonably be expected if they were needed to further management objectives. By the same token, the budget could not be viewed as totally flexible in responding to Forest targets—the Forests could not expect a blank check.

Rather than making a decision at the Regional level (as to whether budget or outputs would take precedence), input on the question was requested from each of the Region's National Forests. Each Forest was asked to indicate how they would respond to alternatives A, D, E, and F both with a budget-constraint emphasis and with an output-constraint emphasis. For example, each Forest constructed two separate estimates of costs for Alternative A:

- one for attempting to meet the output levels specified in Alternative B, even in the face of substantial increases in costs; and

- one for attempting to meet the output levels specified in Alternative B only insofar as would be possible with relatively minor increases in costs.

After reviewing the information from the Forests for these paired alternatives, it became clear that the overall purpose and theme of the original alternatives had more influence than either the budget or output emphases.

In general, cost differences between the paired alternatives were quite small. In the A and the D pairings, 82 percent of the budget line items differed by less than 10 percent. Moreover, in A's pairings, more than half the Forests showed no difference between the paired alternatives at all. Those Forests literally saw no difference between an Alternative A with an output emphasis and an Alternative A with a budget emphasis.

Alternative E showed even less of a difference between its two members, with 88 percent of the budget line items differing by less than 10 percent. In the case of the Alternative F pairings, budget line items differing by less than 10 percent amounted to 94 percent of the total.

In some instances the Forests were able to use substitute methods which closely approximated the cost and the efficacy of the excluded methods. In other instances, the substitute measures were prohibitively expensive. In those cases the work was not done and the effect was noted as a reduced output level. Each alternative had a unique mixture of vegetation management practices.

The vegetation management team was faced with the prospect of analyzing two very similar alternatives for the themes present in each of the alternatives A, D, E, and F. That duplication would have yielded very little additional information.

Accordingly, the interdisciplinary team agreed that team members responsible for compiling specific Forest information would review and validate their respective data. They then determined which data from the pairings best represented the levels of activities and costs that best fit the theme of the alternative.

Thus, in their present form, Alternatives A, D, E, and F represent the most reasonable and likely balance of costs and work (outputs) that would be expected, given their respective themes.

Duplicate the Pre-Injunction Program

Initial alternatives included both the exact present (1986, with herbicides prohibited) and the actual pre-injunction (pre-1984, with herbicides) vegetation management programs.

These conditions are approximated in Alternatives A and B, respectively, although in their final form alternatives A and B both look forward toward future implementation, rather than trying to exactly duplicate an earlier scenario. There was little point in developing alternatives that do not take into consideration the knowledge gained in recent years in vegetation management and which would not be responsive to the issues identified in our scoping process.

Implementing the Alternatives

As noted at the end of Chapter I, Forest Service actions that affect the physical and biological environment are first examined in an “environmental analysis.” Environmental analysis (sometimes called “the NEPA process”) requires a thoughtful examination of the action, alternative ways of doing (or not doing) it, and their consequences.

Vegetation management actions affect the physical and biological environment. They therefore all require an environmental analysis. As explained in Chapter I, this environmental analysis may be written up in an “environmental assessment” (EA), as an “environmental impact statement” (EIS), or not written up at all (if it is “categorically excluded”).

In this EIS, when an environmental analysis is conducted for an action or project to manage competing and unwanted vegetation, additional emphasis will be given to five aspects of the established analysis and decisionmaking process. (See Figure II-6.)

These five aspects of the NEPA process—the “five steps” discussed here—focus attention on the site-specific ecological context of the competing or unwanted vegetation; carefully examine when action is needed; design and conduct the project carefully; and provide for follow-up on (and learning from) the project.

All of the alternatives have this same structure of action. Each incorporates this five-step process for managing competing and unwanted vegetation. However, each alternative differs in the direction given in different steps.

As noted, the five steps take place within the environmental analysis process. For the purposes of managing competing and unwanted vegetation, they are special points of emphasis—special things that field professionals and managers will consider.

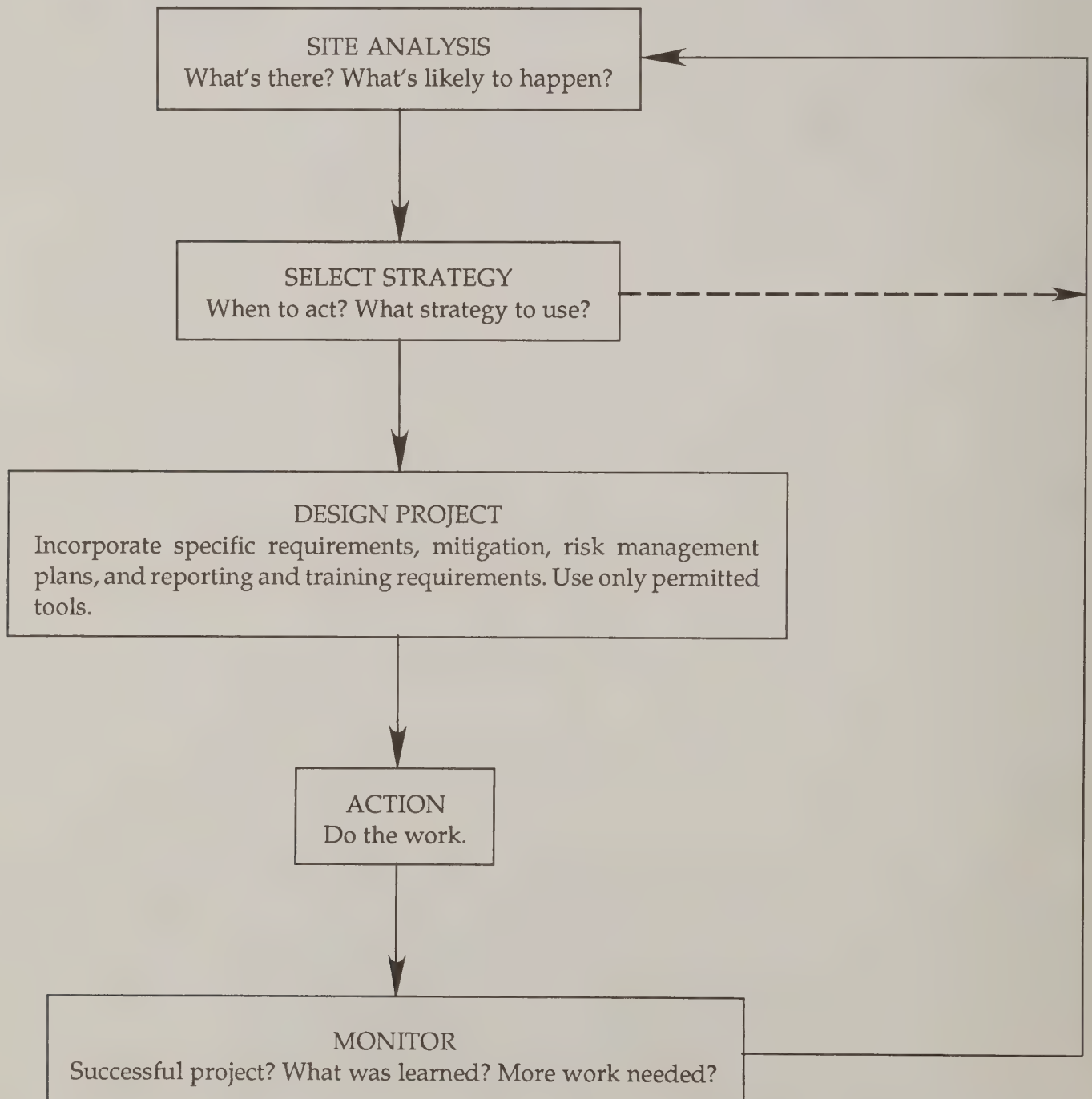
The five steps are familiar to many as parts of environmental analysis (“the NEPA process”), and to others as “the scientific management method”. Others know them as the analytical steps used in “integrated pest management.” They are commonly used in silvicultural prescriptions, and are partly documented in the Timber Stand Improvement Handbook (FSH 2409.26c). They are intended to provide Forest-level direction in implementing the vegetation management portion of any of the nine vegetation management activities covered by this EIS (described in detail in Appendix G).

Environmental analysis is not a lock-step process. Parts may be done in various order and some parts done several times. The five steps in managing vegetation mesh well with environmental analysis. Much occurs within “scoping,” where the scope of the action, its

Environmental Analysis

Figure II-6

“Five Steps” in Managing Competing and Unwanted Vegetation



context, and further analyses are examined. Figure II-7 illustrates how the five step vegetation management process fits within environmental analysis.

Figure II-7

How the Five Step Vegetation Management Process Fits Within Environmental Analysis

Environmental Analysis ("The NEPA Process")*

Scoping

- identify the action
- identify agencies
and responsible official
- look for issues
- explore possible effects
and existing direction
- assess public participation needs
and make contacts
- identify skills needed
- convene interdisciplinary team,
identify cooperators, assign tasks
- expand public involvement
as appropriate
- plan for an orderly analysis
- (analysis criteria, issues,
alternatives, other analysis,
public involvement)

Collect Data

Interpret Data

Develop Alternatives

Estimate Effects

Evaluate Alternatives

Identify Preferred Alternative(s)

Documentation (if appropriate)

Decision

Implementation

Monitoring

Vegetation Management Steps

Site Analysis

Site Analysis, Select Strategy

Design Project

Design Project

Design Project

Design Project

Site Analysis, Design Project

Site Analysis

Select Strategy

Design Project, Site Analysis

Site Analysis, Select Strategy

Select Strategy

Select Strategy

Select Strategy

Action

Monitor

*Adapted from Exhibit 3, FSH 1909.15, 06

The Five Steps in Managing Unwanted and Competing Vegetation

Each alternative attaches different direction to different steps, however all alternatives require this five-step structure of analysis, action, and follow-up, within the established NEPA process.

Step One: Site Analysis

A project may be initiated as a result of any of a number of planned activities, such as proposed timber sales, right-of-way or campground maintenance, or an observed problem such as increasing populations of noxious weeds.

The first step in gathering information is to identify the site and the affected area. Scale is important. The site should be small enough that its ecological systems will respond similarly to treatment. However, when cumulative and synergistic effects are possible, a wider area may need to be considered.

Specific information gathered depends on project needs and objectives. There are several standard Forest Service inventories designed for specific projects. They are based on years of experience and allow efficient data transfer. They include physical characteristics such as aspect, elevation, and slope. Exams designed for vegetation management, such as "RESERV" used in southwestern Oregon, incorporates an extensive array of biological variables including diameter and height growth rates, cover, and evidence of various types of environmental and animal damage. For a great majority of cases, one of these standard exams would serve this first step well.

The analysis process closely follows the existing environmental analysis process as directed in Forest Service Manual 1950 and Forest Service Handbook 1909.15. As in the current environmental analysis process, the level of analysis, detail, and documentation varies with the scope of the proposed project (see the introduction to this section and Figure II-7).

Analysis includes a description and interpretation of the physical and biological characteristics of the site. It also includes an evaluation of the relationships between the unwanted vegetation and the potential for damage; the consequences and efficacy of alternative actions; the risks involved; prediction of expected results with the chosen course of action; and disclosure of the quality of the information and uncertainty involved in the analysis.

Past practices may affect the site's present performance. When

interpreting the site's physical and biological characteristics, emphasis is placed on understanding the potential—rather than current—competition and production.

Production depends on the average condition (for example, the average temperature) but extremes can also have a profound affect on vegetation growth. Both extremes and averages of environmental factors that affect growth and survival should be considered.

Site analysis, analysis of local operational data, and extrapolation of research can be used to establish the damage and action threshold for the project, and to establish the need for action. Yet, in some cases, these relationships may be difficult or not yet possible to establish. In such cases, the theme of the alternative provides direction to managers. Alternative G, for example, advises action to reduce potential damage even if not all factors are fully understood.

The potentials for environmental damage and health risks are analyzed, considering both long- and short-term aspects. Methods and strategies are analyzed for their biological and economic effectiveness.

Damage and Action Thresholds

Before describing each strategy, the concepts of action and damage thresholds should be defined, because selecting a control strategy requires knowing what level of damage or competition (if any) is acceptable. The concepts are presented using an example from reforestation of a clearcut timber harvest unit where other vegetation competes with the desired conifers.

Figure II-8 illustrates a typical post-harvest, post-burn condition where the competing vegetation plant cover has been reduced significantly.

Early sprouting or increases in cover do not provide intense competition. If allowed to grow, however, they may cause unacceptable damage. This level of competition, or damage, is called the damage threshold. Levels of cover (competition) above the threshold are unacceptable; levels below are deemed acceptable.

In many cases, action is needed to avoid damage. It should be taken sometime before unacceptable damage levels are reached. The time or condition that triggers this action is called the action threshold.

Thresholds depend on site-specific and species-specific conditions and Forest goals. Often, these critical points are not known. Although goals (to prevent a specified level of growth loss or damage) may be clear, information on species growth patterns under differing environmental conditions is often lacking, and projects will be implemented under some degree of uncertainty.

Step Two: Select Strategy

Figure II-8

Illustrating Strategies and Thresholds In Managing Competing Vegetation

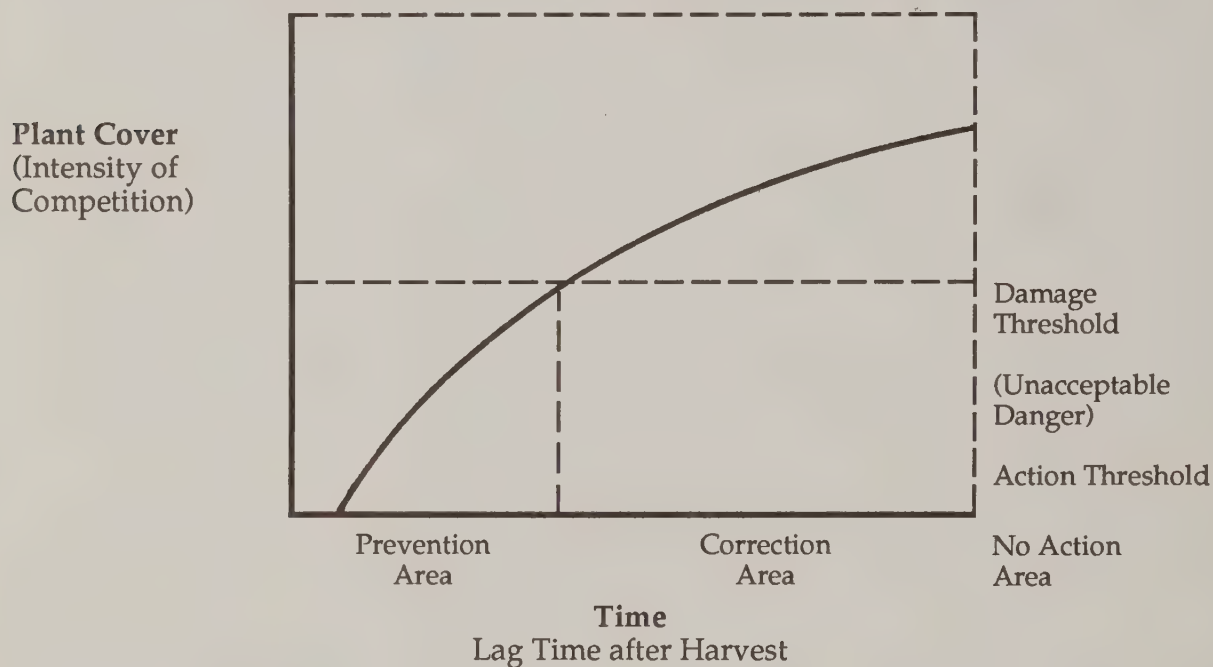
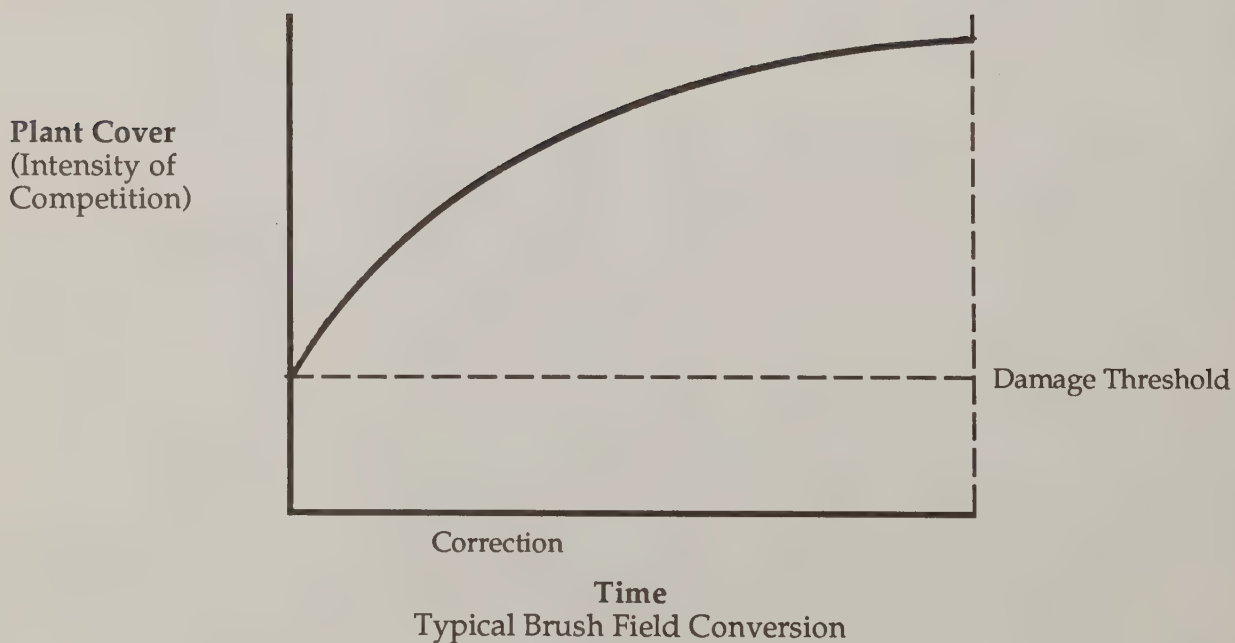


Figure II-9



The Four Strategies of Vegetation Management

The four general strategies for managing competing and unwanted vegetation are:

- *prevention;*
- *maintenance;*
- *correction; and*
- *no action.*

Prevention here means initiating action before unacceptable damage takes place—before the damage threshold is reached (see figure II-8). Actions are usually applied early, and the action threshold is low. Control of damaging species can be achieved in the early developmental stages, using less energy and (usually) fewer applications. The difference between the damage threshold and the action threshold is usually great, and the relationships between species are usually well understood.

This strategy is common, and appropriate for all alternatives except Alternative C.

Maintenance supports the current condition. Maintenance—keeping the system fine-tuned—may be most appropriate in some programs when stability, rather than cyclic variation, is valued. Examples include maintaining a constant supply of wildlife forage or keeping the noxious weed population under control. The damage and action thresholds are often close, and treatment is usually administered in small, frequent doses. Fine tuning is often all that is necessary. The ecological relationships are usually understood. This strategy is appropriate in all alternatives except Alternative C.

Correction is action taken after the damage threshold has been exceeded. Converting brushfields or hardwood stands to conifers is an example of appropriate use of corrective action. The conifer stand is at a point in time when the level of competition is already exceeding the damage threshold and unacceptable growth loss is occurring. Figure II-9 illustrates that condition and is essentially the upper right portion of Figure II-8. Correction may also be the appropriate strategy when there is a high degree of uncertainty about the competitive ability of a species. Action may be delayed to monitor and establish a damage threshold. In some cases action may not be necessary, in others, correction may be needed.

Information on damage thresholds for specific species on various sites is needed. Some will be provided by research, but site-specific data will be provided by detailed monitoring and record-keeping during and after project implementation. Thus, each project will add to the data base that can be used to establish thresholds, reduce the level of uncertainty, and increase efficiency.

Corrective strategies usually require high energy and resource levels compared to other strategies. In addition, several treatments may be required to bring damage levels below the threshold.

Correction strategies are appropriate in all alternatives. In Alternative C, correction may be used to correct a situation threatening human health.

No action means no interference with natural processes by man. Successional cycles, fuel accumulation, growth loss due to competition, and damage due to noxious weeds are accepted along with their indirect effects. This strategy requires little to no energy or resources. It is essentially the theme of Alternative C, and may be appropriate under some conditions when implementing other alternatives.

Step Three: Design Project

Good design depends on thorough examination of the site, review of the available research, and complete analysis. A number of elements must be knowledgeably combined to produce a coherent project plan. Some of the elements will be the same regardless of the alternative selected; others will vary by alternative.

Elements involved in design include Forest Service goals, program objectives, project objectives, alternative theme, design criteria, methods, scheduling, and mitigation (if needed). Forest Service goals, program objectives, and project objectives vary little among the alternatives. Conversely, theme, design criteria, and methods are important variables distinguishing the alternatives.

Design Criteria

The alternative theme and design criteria govern the project's design. Each alternative emphasizes a combination of the four strategies given above and deals with issues derived from public input by varying the emphasis placed on each of the design criteria (the design criteria reflect issues raised by the public).

Human Health Assurance

The alternatives will vary in the standards required in safeguarding human health. Major differences are the degree of risk to forest workers and the general public. For example, in response to concern over public safety, Alternative A prohibits the use of herbicides. However, if manual methods are used instead, there is increased health risk to forest workers.

Environmental Effects

The environmental effects of the methods, tools, and specific techniques are major concerns in all the alternatives. In all cases, impairment of long-term productivity and long-term environmental damage

are to be avoided. However, under Alternative G a greater risk of short-term adverse environmental impact on the site is accepted to achieve an increase in commodity output. On the other hand, in Alternative D the risk of adverse environmental effects is of higher concern than commodity output.

Use of Natural Processes

Some alternatives will direct the managers and professionals to design projects and select tools that most closely incorporate and encourage natural ecological processes; others endorse these as well as active manipulation and alteration of these processes.

Economic and Social Effects

In addition to the effects on the physical and biological aspects of the environment, there are also effects to the economic and social parts of the human environment. The alternatives vary in the importance given to positive and negative economic and social effects resulting from the methods and project designs chosen. Some will accept some short-term disruption of economies and communities for long-term biological and physical benefits; others attach greater importance to maintaining economic and social conditions.

Public Involvement

Existing policies on public involvement will be met. Each of the alternatives solicit various levels of involvement through various stages of major and sensitive projects.

Permitted Tools and Techniques

Some alternatives explicitly prohibit some tools (such as herbicides); others permit selection from a full range of tools and techniques.

Commodity Production Targets

Some alternatives instruct managers to place substantial emphasis on the maintenance of the production of commodities to meet or exceed program targets; others attach less importance to meeting these "output targets" until experience in the widespread use of newer vegetation management techniques can be incorporated into the program targets.

Based on predictions made during analysis, some mitigation may be necessary. In many cases, the project can be designed to avoid, minimize, or reduce adverse environmental impacts. If not, rectification or compensation as mitigation are considered.

Mitigation measures are method-specific, and can be found following the discussion of methods.

Good overall analysis will uncover the need for mitigation. Proper design will usually satisfy it. However, project administrators should be alert for further needs during the implementation phase.

A risk management plan should be a part of every project to evaluate and manage human health risks. Safety plans and spill plans are examples of elements needed in such plans. The plan should be appropriate for the specific project, considering exposure of workers and the general public to risks, the extent of the area covered, and the persistence of the area covered, and the persistence of the methods used.

Step Four: Action

With the analysis and design presented, and the alternatives and effects displayed, the line officer decides on implementation. Training, expertise and accountability will assure that projects are carried out as designed, under specified conditions.

Administrators will pay close attention to unanticipated on-site factors that would increase damage to the natural environment and will be fully aware of the theme and spirit of the design.

Good record-keeping is as important in implementation as in gathering information (step one of the process). It is particularly important if changes are made on the spot in the design. In fact, the monitoring process begins here.

Step Five: Monitoring

Monitoring is assuring that the project is implemented as designed, and recording the result. Many of the same variables inventoried during the information gathering phase (step one), are remeasured and evaluated against the predicted results and project objectives.

Monitoring assures that mitigation measures are carried out, and may be used to evaluate whether further mitigation is needed.

The information can be used to validate or refine techniques and activities. In some cases, an activity may prove to be unnecessary, or may need refinement to produce desired results. Ineffective and costly techniques can be eliminated.

Monitoring may also help to clarify ecological interrelationships between unwanted vegetation and the environment, or between unwanted vegetation and crop trees or other more desirable species.

Most monitoring is done within the project area on target species, crop trees, and nontarget species of concern, such as rare or sensitive species. However, downstream monitoring is common where herbicides are used; stream turbidity may be monitored if mechanical methods are used; and remote airsheds may be monitored when areas are burned.

Monitoring during implementation may be critically important if design changes are made that affect the intensity of application or

alter the techniques used. Most monitoring is done immediately after project completion, and at appropriate intervals thereafter. If the rate of change is high, as with invasion of annual noxious weeds, yearly monitoring may be necessary to maintain weed-free rangeland. If change occurs slowly, several years between measurements may be adequate.

The most difficult monitoring will be for long-term effects. The variables measured will be the same, though some may be added in the future. The difficulty lies in assuring consistent measurement of the treated area, and in maintaining complete records through the rotations. Precise identification of treatment area, particularly where treatment levels vary within a project area, is essential.

9

Chapter 2
The Alternatives

Methods and
Mitigation
Measures

Mitigation Measures and Vegetation Management Methods

This section presents the “mitigation measures” used to avoid or reduce potential environmental impacts. They are presented in the context of the five “methods” used to manage competing and unwanted vegetation.

The five general methods of managing competing and unwanted vegetation are:

- biological*—the use of plants or animals for control;
- prescribed burning*—the managed use of fire;
- manual*—the use of hand-held tools (includes power tools);
- mechanical*—the use of tractors or other large machines; and
- herbicides*—the use of herbicides (aerial and ground).

Mitigation measures are designed to reduce, avoid, minimize, rectify, or compensate for impacts on the environment which might result from vegetation management activities. The mitigation measures incorporated here draw from existing direction found in Forest Service manuals and land and resource management plans, information in the research literature, and the accumulated field experience of Forest Service professionals.

Several mitigation measures will apply regardless of the alternative selected or the vegetation management method employed. These common mitigation measures are listed on the following page.

Most mitigation measures, however, are applicable to a specific method, and will be presented following the discussion of the relevant method.

In addition, certain specific restrictions or changes in management have been built into the alternative descriptions themselves. These are mitigation measures that apply only to that specific alternative. Examples include the prohibition of 2,4-D, amitrole, diuron, and fosamine in Alternative E, and the restrictions on slash burning in Alternative F.

Chapter IV presents the environmental consequences of the alternatives assuming the mitigation measures are followed. The chapter also provides information on the effectiveness of the mitigation measures.

Mitigation measures for use of fire and herbicides are more numerous and detailed than for the other methods. This is due to the

public interest directed toward these methods during the development of the EIS.

Prescribed fire and herbicides are used in managing National Forest lands and resources only as ways to control competing and unwanted vegetation. Manual, mechanical, and biological methods are used in other activities including timber harvest, road construction, and fire fighting. Directions governing use of these methods in these other activities apply when they are employed for managing competing and unwanted vegetation. Existing direction on mitigation measures for these methods is summarized in this document.

Mitigation Measures Common to All Methods and All Alternatives

The following mitigation measures will be applicable to all methods of managing competing and unwanted vegetation, and are common to all alternatives.

The first three measures apply to silvicultural activities (site preparation for planting and conifer release from competing plants).

Silvicultural activities will employ the following mitigation measures for all methods:

1. A documented prescription will be prepared or approved by a certified silviculturist. Diagnosis and prescription will follow direction in Forest Service Handbook 2409.26d (Silvicultural Examination and Prescription Handbook). Prescription will include five elements:

- describe physical and environmental conditions;
- describe biological conditions;
- state management objectives;
- consider treatment alternatives, as well as a recommended treatment; and
- identify monitoring requirements.

Prescriptions should recognize the forest as an ecosystem, be sensitive to the quality of data used, and objectively analyze how well an action would meet management objectives. A no-treatment or deferred action will be considered in all diagnoses.

2. Site-specific diagnosis and analysis will meet standards established in Forest Service Handbook 2409.17 (Silvicultural Practices Handbook). Knowledge and skill levels for certified silviculturists are defined in Chapter 8 of this handbook.

Standards defined in FSH 2409.17 will be met for project evaluation, implementation, and monitoring.

Monitoring will be designed to determine whether:

- prescription and management objectives have been met;
- remedial treatment is necessary; and
- findings can be used to strengthen future prescriptions.

3. Guidance for diagnosis and determination of treatment need contained in Forest Service Handbook 2409.26c (Timber Stand Improvement Handbook, Chapter 10) will be consulted. This handbook includes direction for the determination of objectives for vegetative response and establishment of time frames.

Evaluations of treatment methods must consider effectiveness, viability, and efficiency. The value of early plant community monitoring and maintenance in order to help reduce the magnitude of future release needs should be recognized.

Additional mitigation measures will be employed for all management activities.

4. Scoping and environmental analysis will be conducted for each proposed project. This analysis will follow guidance in Forest Service Manual 1950 (Environmental Policy and Procedures) and Forest Service Handbook 1909.15 (Environmental Policy and Procedures Handbook).

Potential adverse effects, including those to soils, long-term productivity, water and air quality, vegetative diversity, wildlife, fish, and threatened, endangered, or sensitive species will be evaluated. The potential for cumulative impacts of past and proposed projects will be considered during Forest- or project-level environmental analysis, and mitigated where possible.

5. Each project proposal will include a Human Health Risk Management Plan. As appropriate, this may include elements such as:

a. Project Risk Plan—includes the identification of personal protective equipment, special orientation and training needs, hazard identification, first aid training or supplies, and safety meeting schedule. The basic reference is Forest Service Handbook 6709.11 (Health and Safety Code Handbook). Medical support facilities, as well as accident investigation and reporting responsibilities, will be identified.

b. Environmental Monitoring Plan—includes water monitoring procedures, and standards, requirements for notification of adjacent landowners or forest visitors, and record-keeping needs.

c. Spill Incident Response Plan—for projects involving movement or handling of hazardous materials. This plan will identify responsibilities, notification procedures, and containment or cleanup measures.

d. Prescribed Burning Plan—includes identification of preburn monitoring of fuel moisture and weather conditions, the burning prescription, and assessment of risk of fire escape, coordination needs, and special smoke management needs.

e. Herbicide Application Plan—this will identify organization and support needs, calibration procedures, equipment inspection procedures, communications needs, search and rescue procedures, batching procedures, public contact procedures, posting and signing needs, and herbicide accountability standards. Special precautions for applicators, mixers and loaders will also be identified. This plan is not applicable to Alternatives A and C.

The size and complexity of each vegetation management project, along with the specific methods and techniques employed, will define the content of a project Human Health Risk Management Plan. The design of every project, however, will evaluate the health risks for workers and the public, and make specific provisions for the management of risks.

6. Training, direction, and quality control will be provided at all administrative levels—the Regional Office, National Forests, and Ranger Districts. The purpose is to help project planners, administrators, and managers perform their responsibilities effectively and efficiently. Training and orientation will be used to develop a common understanding of management objectives, restraints and mitigation measures, and concepts necessary for the implementation of the vegetation management program.

Forest Pest Management, along with the program managers and staff groups, will be responsible for providing training and monitoring to assure that:

- a) project planners and decisionmakers will acquire a working knowledge of the process for managing competing vegetation (Chapter II); and
- b) information exchange takes place when new or modified vegetation techniques, methodologies, or monitoring strategies are developed that show potential for more widespread use.

While training is a major element of all alternatives, the content and emphasis would vary between alternatives. For example, Alternatives D and G incorporate some shift in management emphasis in comparison with Alternative B. This means that training would be geared toward the understanding of some new concepts or restraints in order to implement these alternatives. Likewise, added restraints on the use of herbicides are incorporated into Alternative E, and would be reflected in training efforts during the implementation of this alternative. Under all alternatives, however, training, orientation, and quality control will be required for the successful implementation of the desired vegetation management program.

Descriptions of the five methods of managing competing and unwanted vegetation are presented here, followed by the mitigation measures specific to each method.

Biological Methods

Generally, biological methods include use of animals or insects to control vegetation. Grazing animals and leaf-eating insects are the most commonly used methods. There are, however, a number of less commonly used methods. Seeding of desired species, genetic adaptation, or use of natural and advance regeneration can be used successfully in certain situations. Other techniques involving biological herbicides, allelopathy, and pathogens are still experimental.



Grazing animals and leaf-eating insects are the most commonly used biological methods of vegetation management.

Prolonged or forced grazing of domestic livestock (cattle and sheep) can be used to control the composition or amount of competing vegetation. This differs from the typical grazing program in that vegetation control, rather than animal weight gain or forage utilization, is the primary objective.

Livestock use can be considered when palatable or preferred species are a significant component of the vegetation, and an area large enough to support the herd or band is available for management. Careful coordination with range and wildlife habitat management goals is normally required.

Grazing can have several advantages. In the proper mix of brush, weeds, and grasses, grazing can effectively control the vigor of undesirable vegetation. Grazing can be cost-effective and may often be done in conjunction with existing range permits. On some nutrient-

deficient sites, the animals can be beneficial because they convert vegetation directly into an available source of nitrogen.

Several disadvantages must also be recognized. Timely project administration and experienced herders or riders are needed to control the duration and intensity of use. This is particularly true with sheep movement and bedding. Conifer seedlings can be susceptible to browsing or trampling damage, especially during the spring season. Livestock must be strictly controlled within riparian areas or on soils subject to compaction in order to prevent damage to soil and water resources.

Water sources, the extent of the forage, the quality or nutritional value, access, proper fencing, and control can all be limiting factors.

Experience has shown that willing operators are not plentiful. In order to obtain a release effect in conifer seedlings, or significantly reduce undesirable vegetation, livestock must be held in an area much longer than normal. Forced grazing such as this can adversely affect animal weights and marketability, a serious problem for many stockmen.

Livestock have been effectively used to control competing vegetation in the rangeland rehabilitation programs on the Forests of eastern Washington and Oregon. Sheep and cattle have also been used effectively for conifer plantation maintenance. Specific examples of successful livestock use on an operational basis can be found on the Fremont and Siuslaw National Forests.

The selective release of insects has been used to weaken or kill specific target plants in certain noxious weed situations. These biological control efforts require close coordination with several state agencies and county weed control programs, as well as federal agencies, including the USDA Agricultural Research Service. Insect releases can be effective when the population of target plants is large enough to support the insects or nematodes, and adequate numbers of insects can be obtained through USDA Biological Control Laboratories.

Insect adults and larvae can damage noxious weeds by feeding on seeds, girdling roots, and forming galls. Efforts are normally made to harvest the insects for redistribution purposes. Selective release programs have a history of success in local situations. A great deal of research effort has been directed toward this technique in recent years.

The disadvantages of this biological vegetation management technique are the intensive monitoring efforts required and the difficulty of obtaining insects. While the introduction of host-specific insects is carefully studied and planned in advance, there is always the potential risk of disrupting natural ecosystems.

Some examples of host-specific insects successfully used in the

Pacific Northwest to control target vegetation include the cinnabar moth (tansy ragwort); fleabeetles and midges (leafy spurge); seedhead weevils (yellow starthistle); root and stem boring weevils (Canada thistle and Scotch broom); and seedhead flies (diffuse knapweed).

Seeding with desired species is a preventive technique used on newly disturbed sites such as roadsides and other rights-of-ways. Early seeding of low-growing grass and/or brush species, often accompanied by fertilization, may inhibit later invasion of the site by taller shrubs and trees. Once a stable plant community is established, the site becomes self-maintaining. More research is needed in a variety of site conditions to determine which species are successful under what conditions.

Through the Regional genetics program, the technique of genetic adaptation is being explored. Trees with the potential for fast, early growth are selected to be used as a seed source. The use of stock developed from these seeds may limit the need for conifer release in some situations. Thus far, the program has been limited to a few commercially important species. But, as results are evaluated, more species may become available and adapted for site-specific needs.

Taking advantage of natural seedlings and advance regeneration (established trees from the previous stand) can, in some cases, reduce the need for competition control. Natural seedlings go through a rigorous natural selection process, and are uniquely and specifically adapted to the site. There are usually a number of different species present, adding to the diversity and increasing the chances for survival of a healthy stand. In many cases, they grow faster than the planted trees.

Using advance regeneration has the same advantages as using naturals, but their older age and larger size can give them a significant advantage over the competition. However, advance regeneration stands can be diseased, suppressed, or damaged, and do not always represent a positive opportunity.

Several biological techniques show promise in the experimental stage, but are not yet operationally proven in forestry. These include:

Biological herbicides—naturally occurring microbial or viral agents similar to those which have proven effective in insect control and agriculture; and

Pathogens and allelopathy—use of introduced pathogens and chemicals produced by plants to repel or inhibit competitors.

Uneven and multi-aged management may present some options when used in a manner consistent with site and management requirements. Removing selected age classes may not allow the competitors to gain dominance on a site, since many brush species require

full sunlight for optimum growth. The remaining crop trees expand to take advantage of the newly available resources left after harvest.

In order to minimize soil disturbance and damage to the residual stand in an uneven age management regime, the terrain must be gentle. Otherwise, long-term damage caused by multiple entries would far outweigh the benefits to vegetation control. The Region and Forests have standards and guidelines dealing with the selection of harvest systems.

Biological Mitigation Measures

Existing direction found in Forest Service Manual 2200 Range Management and Forest Service Manual 2500 Watershed Management provides for protection of resources during livestock grazing. Standards and Guidelines in Forest land management planning documents address local conditions and measures necessary to minimize impacts on soils and vegetation due to trampling by livestock.

1. Livestock will be strictly controlled in the vicinity of wetlands and riparian areas to prevent trampling and compaction of wet soils, water contamination, and destruction of riparian vegetation and streambanks. Specific management direction for protecting riparian areas, wetlands, and threatened, endangered, and sensitive plants is found in the applicable land and resource management plans.

2. All Forest Service uses of biological control organisms will be in cooperation with the USDA Agricultural Research Service or under individual, approved state programs.

3. Project planners will inform downstream water users who could potentially be affected by biological contamination of surface water.

Prescribed Burning Methods

Prescribed burning is the controlled use of fire under predetermined conditions to achieve specific, preplanned land management objectives. Prescribed burning, as a vegetation management method, has advantages. In the right situation, it can be environmentally correct and very cost-effective.

Like the other vegetation management methods, it does have disadvantages. First, fire is not very selective. The effects of fire on a particular organism are not always predictable, as they depend on fire severity and residence time, as well as the particular species' heat/fire tolerance. How long the effect lasts depends upon each species' vigor,

capacity for sprouting, and the heat tolerance of its seeds.

If too much fuel is consumed, the soil can be damaged and water quality may be affected. The smoke from prescribed fires can degrade air quality; and a prescribed fire may escape, become a wild-fire, and do considerable damage to the environment as well as to man-made improvements.



Fire, under predetermined conditions, can be used in some circumstances to achieve land management objectives.

More information on prescribed burning effects is presented in Chapter IV, Environmental Consequences.

The Forest Service requires that a written, site-specific prescribed burning plan be prepared and approved by a person with line-officer authority for each project. The purpose of the prescribed burning plan is to ensure that resource management objectives are met and that the site and environment are not harmed.

A prescribed burning plan must include the following:

1. Description of the burn unit and the resource management objectives: lists the location, size, aspect, slope, fuel type(s) and loading(s), and the root reasons for the burn (site preparation, hazard reduction, improve deer habitat, etc.).
2. The range of acceptable results: expressed in quantifiable terms (reduction in loading(s) of specific fuel class(es), numbers of planting sites, stimulation of growth of specific food plants, etc.).
3. The burning prescription: includes weather and fuel moisture criteria that will produce the results specified in 2, and fire behavior that will enable the burning crew to confine the fire to the treatment area.
4. Preburn monitoring: describes how the fuel moisture and weather conditions will be monitored to determine when they are within the burning prescription; indicates exactly which elements are

to be monitored; the methods to be used; and the locations where data will be collected.

5. Preparation needed for burning: identifies the location of fire breaks, hose lays, and other steps required to prepare the site for burning.

6. Risk assessment: quantifies the risk of fire escape and the possible consequences of a fire escape.

7. Provision for preburn coordination: notification of regulatory and cooperating agencies and the general public, if appropriate, of the place and time of the burn.

8. Smoke management: identifies roads, airports, population centers and scenic areas that would be adversely affected by smoke; lists special procedures and conditions that will prevent smoke intrusions into those places.

9. Safety and protection of improvements and fire-sensitive features: special safety considerations, special hazards, etc.; things, areas, etc. that must be given particular consideration when planning and executing the burn.

10. Firing, mop-up, and patrol procedures: specifies exactly how the burning will be done.

11. Contingency actions in the event there is an escape: whom to call, control line location, etc.

12. Post-burn evaluation: procedures for comparing the actual results, in quantifiable terms, against the burn objectives.

13. Cost and funding.

14. Cost summary.

Techniques

There are three techniques of prescribed burning: broadcast burning; pile burning; and underburning.

Broadcast burning is the burning of natural and activity-generated forest residues, scattered (more or less uniformly) over a clearcut. The most commonly used devices for igniting broadcast burns are hand-held drip torches and helitorches. A helitorch is a fuel dispensing device suspended from a helicopter. Helitorches are used when there is a need to ignite an area rapidly or when it is unsafe to light by hand. Rapid ignition makes it possible to burn at higher fuel moistures, thereby reducing the amount of smoke produced.

Mechanical pretreatment is often done in combination with broadcast burning. For example, brush or saplings may be cut prior to burning. Logging residues may be crushed to reduce fire intensity and rate of spread.

Broadcast burning, depending on the amount of fuel that must be removed, can be done during spring, summer, and fall. This levels the workload and lessens the impact on air quality.

Pile burning of forest residues is done in conjunction with “PUM” (piling of unmerchantable material) and “YUM” (yarding of unmerchantable material) to concentrate slash into piles or windrows. PUM is done manually or with a tracked or rubber-tired tractor; YUM is done using skidders or cable logging machinery.

Generally, piles and windrows are burned in the fall after snowfall/rain to minimize the risk of escaped fires. The most commonly used devices for igniting piles are hand-held drip torches and alumgel packets. Alumgel is a gasoline thickening agent. The jelled gasoline is put into plastic bags, placed inside the piled slash, and ignited electronically from a remote location.

Fire severity in pile burns is typically very high; soil under the burning pile is often sterilized by the high soil temperatures caused by the relatively long residence of the fire.

Underburning is burning beneath a stand of trees to reduce woody debris, set back unwanted vegetation, or to encourage the growth of desirable forage and browse plant species. The most commonly used device for igniting an underburn is the hand-held drip torch. Underburning is done only when fuels are barely dry enough for the fire to spread properly. Low air temperatures and moderate air movement are prescribed to dissipate the convective heat which would otherwise damage the crowns of the overstory.

Prescribed Burning Mitigation Measures

Adherence to the following guidelines will prevent unacceptable damage to soils, water quality, and air quality.

1. Extreme care will be taken to avoid consuming more of the residues and forest floor (litter and duff) than absolutely necessary. This will assure physical protection to the soil and retention of nutrients.
2. Consumption of fuels will be moderated on steep (less than 60 percent) slopes and on sites with soils derived from granitic materials or volcanic ash, which are highly erodible.
3. An unburned buffer of vegetation along streams will be maintained to protect riparian vegetation and provide a filter to reduce sedimentation. Care will be taken to limit the severity of the burn in and along intermittent streams. Specific directions for protecting riparian areas and threatened, endangered, and sensitive plants are found Regional Guides and in individual Forest Plans.
4. Protection of air quality will be a key issue in the considera-

tion of prescribed burning as a treatment method. The Forest Service will comply with all State and local air-quality regulations. The Forest Service will be especially careful to not limit the visibility in National Parks and wildernesses (Class I areas) during the period from July 4 to Labor Day.

5. Prescribed burning will be planned to avoid smoke intrusion into smoke-sensitive areas identified in the Oregon and Washington Smoke Management Plans.

6. The "best available technology" will be used to reduce smoke, taking into account the environment, compatibility with other land management practices, and costs, as determined on a case-by-case basis. The "best available technologies" applicable to prescribed burning include (but are not limited to):

- utilizing or removing fuel material;
- reducing breakage (cable/directional felling);
- accelerating mop-ups of burns;
- igniting fires rapidly; and
- burning during optimum fuel moisture conditions.

7. In order to protect the visibility in Oregon Federal Class I areas, the Oregon State Implementation Plan prohibits prescribed burning during the July 4-Labor Day period in the following counties: Lane, Linn, Marion, Clackamas, Multnomah, Hood River, Columbia, Clatsop, Tillamook, Yamhill, Polk, Benton, Lincoln, and Washington. There are three exceptions:

- for research;
- hardwood conversion; and
- above 5,000 feet elevation on the Willamette National Forest.

However, the burning will be conducted in accordance with the Oregon Smoke Management Plan, which designates all Cascade wildernesses and Crater Lake National Park "smoke-sensitive" areas.

8. The Forest Service will comply with visibility protection guidelines for Washington's Federal Class I areas during "visibility important days" from July 4-Labor Day as required by the Washington State Implementation Plan, and in accordance with the Washington Smoke Management Plan.

Manual Methods

Manual methods utilize hand labor to remove competing vegetation or noxious weeds, or to modify the immediate environment so favorable conditions exist for desired plants.

Scalping during planting is one of the most commonly used manual methods. A small area is cleared with a hand tool to remove potentially competing vegetation in the vicinity of the planted tree. Mulching (with paper, plastic, or other materials placed on the ground surrounding the tree to prevent moisture loss) or the growth of species that compete with the target species are rarely practiced.

Techniques



Hand labor is sometimes used to remove competing vegetation or noxious weeds, or to modify the immediate environment to favor desired plants.

Power saws are commonly used to achieve release objectives. Competing brush is cut, allowing the crop tree more space and resources to grow. Use of power saws for release has increased since suspension of herbicide use in the Region. Hand pulling of weeds or small competing seedlings, and girdling (removing a band of bark from around the stem) is occasionally done for conifer release. Hand pulling is frequently used at recreation and administrative facilities, tree nurseries, and occasionally along roadsides, where noxious weeds commonly invade.

As in all methods, timing of operations is critical. For example, the ability of brush to resprout is partly dependent on when it was cut, and the effectiveness of pulling is dependent on the timing of germination.

The advantage of hand methods is their specificity and low impact on the soil surface. Particular species can be targeted. In riparian areas, and sites with sensitive plants, hand methods assure that

only target species are treated.

The major disadvantages of manual methods are their lower production rates, higher costs, and in the case of release, resprouting. Because the root system remains intact, except after hand pulling, the plant retains its vigor and can quickly reoccupy the site.

Working on steep slopes with poor footing, in dense or tall brush, and during exposure to exhaust and gas vapors are potential health risks. Chain saws are dangerous if used unsafely. Available information on risks to the worker is presented in the discussion on health risks (Appendix H).

Manual methods are extensively covered in the Reforestation Handbook (2409.26b) and the Timber Stand Improvement Handbook (2409.26c).

Manual Mitigation Measures

The following mitigation measures apply to all alternatives which utilize manual methods of vegetation management.

1. When manual methods are considered, an analysis of worker exposure to potential hazards and risks will be made. Safety of workers and the potential for serious accidents will be evaluated, and mitigated where practical.

2. As with other methods, a Project Risk Plan will be developed. Items considered should include (depending on the technique used):

- physical dangers (for example, falls, sprains, or danger from snags);
- exposure to exhaust gases, dust, or temperature extremes;
- exposure to vapors during mixing of fuels;
- risks of being cut; and
- exposure to poisonous plants, snakes, or insects.

Mechanical Methods

Mechanical methods of vegetation management involve the use of machines to remove or reduce the cover of competing or unwanted plant species.

Techniques Crawler tractors or low ground pressure tractors outfitted with various types of blades or mowing attachments are the most commonly used techniques. Site preparation is most often accomplished using

various types of blades to remove plants, their roots, and, sometimes, part of the top layers of soils. The technique is named for the extent of the activity. Preparing spots is called scalping; plowing a strip is called furrowing or contouring. In some cases, most of the area is prepared.

Tractors are also used to pile unmerchantable material which may present a fire hazard or create difficult conditions for reforestation. Tractors with attached discs or chains are also used to remove unwanted vegetation for range improvement. Graders, tractors, and other machines use attached brush cutters for roadside brush control.



In mechanical methods of vegetation management, machines are used to remove or reduce competing or unwanted plant species.

Cable systems are also used to yard unmerchantable material which may present a fire hazard or create an obstacle to tree planting.

As with all other methods, the timing of application can affect the success and efficiency of the operation when using mechanical methods. Application is usually timed to avoid sprouting and high soil moisture content.

The advantages of mechanical methods are the low costs and high efficiency (in many cases, the plant, roots and all, is removed).

The intense disturbance of the site is the major disadvantage of mechanical methods, particularly during site preparation. Most techniques are nonselective and remove nontarget plants. There are slope and topographic limitations, except with cable systems, and there is usually some resprouting if the whole plant is not removed.

Mechanical methods, tools, and techniques are extensively covered in the U. S. Forest Service Reforestation and Timber Stand Improvement Handbooks (2409.26b and 2409.26c, respectively).

Mechanical Mitigation Measures

The following mitigation measures apply to all alternatives that utilize mechanical methods of vegetation management. Individual Forest land management planning documents provide direction which may be more restrictive in local situations. The following are examples of existing Regional direction designed to minimize soil compaction and erosion during the operation of heavy equipment.

1. Tractors (both rubber-tired and crawler) are prohibited on slopes exceeding 35 percent, except at designated locations (approved by a soil or water specialist) where significant, adverse impacts can be avoided.

2. Tractors are prohibited on critical soils, such as those with high compaction potential, except at designated locations (approved by a soil or water specialist) where significant, adverse impacts can be avoided. A minimum of 80 percent of an activity area should be left in a condition of acceptable productivity potential for trees and other managed vegetation (see Forest Service Manual 2520, 9/83 R-6 Supp. 45).

3. Tractors are prohibited on soils with high erosion and sedimentation hazard in municipal watersheds.

4. Tractors may be limited to operating only during certain periods in order to maintain long-term productivity of forest and range soils. Timing of operations will be based on soil moisture content and soil properties in order to reduce compaction. The advice of a soil scientist will be sought in determining limited operating periods.

5. Protective buffer strips along streams, lakes, and wetlands will be maintained to create a filter mat to minimize off-site sedimentation. Interpretations of site-specific conditions by hydrologists or soil scientists will be used to determine the width required to prevent accelerated sedimentation. Individual Forest land management planning documents specify standards and guidelines for management of riparian areas.

6. Slash created as a result of mechanical methods of vegetation management will not be piled within the zone of high water flow in stream channels.

Herbicide Methods

Herbicides are used in a variety of activity areas to control competing and unwanted vegetation. All herbicides considered for use are registered by the U.S. Environmental Protection Agency. Treatments are

made within manufacturers' label restrictions and administrative directions. Herbicides are most often applied in mixtures with water or oil carriers; various adjuvants (wetting agents, sticking agents, stabilizers or enhancers, thickening agents, etc.); or dyes needed for environmental monitoring. A discussion of application rates, modes of actions, and product formulations is found in Appendix C (Herbicide Use and Efficacy).



Herbicides—applied via aircraft, overland vehicles, backpack sprayers, or scattered by hand—can be highly selective and effective in reducing competition from target vegetation.

Sixteen herbicides are being considered for use:

GENERIC NAME	COMMON TRADE NAMES *
2,4-D	Weedone, Esteron, DMA-4, Formula 40, others
Glyphosate	Roundup, Rodeo
Picloram	Tordon, Amdon
Triclopyr	Garlon
Atrazine	AAtrex
Dalapon	Dowpon M
2,4-DP	Weedone 2,4-DP, Weedone 170, others
Hexazinone	Velpar
Fosamine	Krenite
Dicamba	Banvel, Banex
Asulam	Asulox
Diuron	Diuron, DMU, Karmex, Krovar
Simazine	Princep, Aquazine
Amitrole	Amitrol-T, Amizol, Weedazol
Bromacil	Hyvar, Urox B
Tebuthiuron	Graslan, Spike

* Trade names are registered trademarks.

Techniques

Four techniques of herbicides application are used:

1. Aerial application, using helicopter or fixed-wing aircraft.
2. Mechanical equipment, using truck-mounted or truck-towed wand or boom sprayers.
3. Backpack equipment, generally a pressurized container with an agitation device.
4. Hand application by injection, daubing cut surfaces, and ground application of granular formulations.

Table II-14

Frequency of Herbicide Use by Activity and Application Method

Method	Site Preparation and Release	Noxious Weeds and Range Management	Rights-of-Way Maintenance	Recreation Site and Facilities
<i>Aerial</i>				
<i>Helicopter</i>	Common	Occasional	Occasional	None
<i>Fixed-Wing</i>	Rare	Occasional	Rare	None
<i>Mechanical</i>	Occasional	Occasional	Common	Rare
<i>Backpack</i>	Common	Occasional	Occasional	Common
<i>Hand</i>	Occasional	Rare	Rare	Occasional

Herbicides can be highly selective and effective in reducing the cover and competitive effects of target vegetation. In many cases the effects are relatively long lasting. The translocated systemic chemicals can effectively minimize sprouting or rapid site reoccupancy. The major advantages and disadvantages of aerial and ground application are presented below.

The major advantages of aerial application are their relative cost efficiency, accomplishment of large acreages in a short time period, the ability to take advantage of target vegetation growth patterns (periods when the target species are susceptible and the crop species is not), and the low impact to the soil surface.

Potential limitations, effects such as unacceptable drift or environmental movement, damage to desirable vegetation, and pesticide handling and disposal needs are addressed in Chapter IV (Environmental Consequences) and in the presentation of mitigation measures following this section.

Disadvantages include the need for a large administration and support organization; the demanding environmental monitoring requirements; timing relative to plant growth; the narrow window of weather conditions required for application; and the wide buffer strips required near wetlands and water courses. When large areas are

planned for treatment, the costs per unit of application decrease, but the possibility for consistent results also decreases because the targets are more likely to be at different stages of growth. This is particularly true when areas to be treated are at widely different elevations.

Ground herbicide applications have the advantage of precise placement of herbicide, and are more adaptable to small or scattered treatment units. It eliminates many of the disadvantages of aerial application, but does not retain the advantages of low cost.

Disadvantages are lower production rates in comparison to aerial application, a need for good road access, restrictions due to steepness of slope and size of vegetation to be treated, and the potential for increased exposure of the applicator (in some techniques) to the herbicide.

The Forests of the Region which have had the largest operational herbicide use programs are concentrated within the central and southern Cascades, and southern Coastal subregions. All 19 Forests, however, have employed herbicides in the vegetation management program. In addition to EPA, herbicide use involves coordination with numerous cooperators (such as state departments of transportation, Bonneville Power Administration, utilities, etc.) and regulatory or quality control agencies (such as state departments of environmental quality, agriculture, or public health, state universities, etc.). Forest Service training, direction, and quality control occurs at all administrative levels during implementation of an herbicide use program.

Herbicide Mitigation Measures

The following mitigation measures apply to all alternatives which involve application of herbicides for vegetation management. They meet or exceed the intent of state forest practices acts.

1. Down-stream water users and adjacent landowners who could potentially be affected by drift, water transport from normal operations, or an accidental spill, will be notified prior to application.
2. All applicable state and Federal laws, including the labelling instructions of the Environmental Protection Agency, will be strictly followed.
3. Herbicides will be applied within the prescribed environmental conditions stated on the label, in the environmental assessment, and in issued permits. This includes considerations of wind speed, relative humidity, air temperature, and chemical persistence when determining timing of application in relation to rainfall.
4. Precautions will be taken to assure that equipment used for

storage, transport, mixing, or application will not leak herbicides into water or soil.

5. Areas used for mixing herbicides and cleaning equipment shall be located where spillage will not run into surface waters or result in groundwater contamination. Whenever practicable, mixing areas and heliports will not be located within domestic/municipal, fish hatchery, or irrigation supply watersheds.

6. Drift of herbicide vapors or sprays will be minimized to within the prescribed buffer strip boundaries. The goal is to optimize droplet size to meet control requirements and reduce risk of contamination due to drift. For aerial applications, fine droplets will be kept to a minimum by techniques such as 1) reducing boom pressure, 2) increasing orifice size, 3) orienting nozzles into air stream, 4) using specialized boom and nozzle designs, 5) minimizing use of straight oil in spray mixtures, and 6) thickening the spray mixture by addition of various foaming agents, thickening polymers, or invert emulsion carriers.

Specific direction on drift control measures, calibration, and characterization of aircraft is contained in handbooks such as the Siskiyou National Forest Aerial Applicators Handbook, 4/82; the Gold Beach Ranger District Aerial Implementation Plan, Spring 1983; and the Region 5 Handbook on Aerial Application of Herbicides, 6/83. These are on file in the Regional Office in Portland, Oregon. Current technology in aircraft and guidance systems, aerial delivery systems, aerial spray models, aerial calibration, microsite weather, and quality control is provided to Forest Service personnel in training sessions such as the National Pesticide Application Training held in Marana, AZ, Oct. 1986.

7. Buffers are required along streams, open water, and wetlands. The following will be considered as minimum, and may need to be expanded depending on local operating conditions.

a. For aerial applications, a minimum unsprayed width of 200 feet horizontal distance will be maintained around wetlands and lakes.

b. For aerial applications, a minimum unsprayed width of 100 feet horizontal distance will be maintained along Class I, II, and III streams.

c. For aerial applications on Class IV (intermittent) streams, a minimum unsprayed width of 50 feet horizontal distance will be maintained if the stream is flowing.

d. For methods other than aerial application, a minimum unsprayed width of 50 feet will be maintained along all flowing streams (Class I, II, III, and IV) and all wetlands.

8. Aircraft operators shall shut off herbicide application during turns and over open water.

9. Appropriate management of streamsides along dry Class IV streams will be determined during the project-level environmental assessment. Predicted rainfall, downstream uses and values, vegetative and soil conditions, and wildlife habitat will be evaluated when considering herbicide use in these areas.

10. When transporting herbicide mixes on forest roads within domestic/municipal, fish hatchery, or irrigation supply watersheds, tanker trucks will use a pilot vehicle. Tanker drivers shall know the Spill Incident Response Plan.

11. Monitoring must be planned as an integral part of the overall vegetation management project. Monitoring will be conducted as described in the Region 6 Water Quality Monitoring Guide for Pesticide Detection (R6-WS-040-1980). Monitoring of a spray operation will be conducted to determine if mitigation measures are 1) being observed, 2) effective in maintaining water quality, and 3) in compliance with state water quality standards.

12. Herbicide use will be conducted in accordance with direction in Forest Service Manual 2150 (Pesticide-Use Management and Coordination). This defines the authority for Forest Service use of pesticides—the Federal Insecticide, Fungicide, and Rodenticide Act. The objectives and responsibilities of the different administrative levels are documented. This directive includes the requirement for environmental documentation, safety planning, and training when pesticides are used.

13. Forest Service Handbook 2109.11 (Pesticide Project Handbook) will be used to direct project planning. This establishes procedures to guide managers in planning, organizing, conducting, and reporting pesticide use projects. Also included is the requirement for a post-treatment evaluation report, and the pesticide-use report.

14. Standards and guidelines in Forest Service Handbook 2109.12 (Pesticide Storage, Transportation, Spills, and Disposal Handbook) will be met. This defines standards for storage facilities, posting and handling, accountability, and transportation. It covers spill prevention, planning, cleanup, and container disposal requirements.

15. Forest Service Handbook 2109.13 (Pesticide Project Personnel Handbook) will be used to define responsibilities and personnel needs, training, and experience needed for large scale aerial or ground application projects.

16. Project safety will be guided by Forest Service Handbook 6709.11 (Health and Safety Code Handbook, Chapter 9). This directive establishes the basic safety rules, as well as storage, transportation, and disposal safety aspects. References and publications to aid in worker safety training are also identified.

17. Individual National Forests will provide guidance for large

and complex projects, as appropriate. This will be in the form of Forest Application Handbooks, Project Safety Plans, Environmental Monitoring Plans, Public Contact Plans, or Law Enforcement Plans. This is where specific requirements for equipment standards, training and quality control, and safety needs are identified for project implementation. Special measures such as spray drift control technology, water monitoring standards, calibration of equipment, and on-site weather limitations are prescribed. These documents also define coordination needs with support organizations and facilities.

18. Pesticide Applicator Licensing and Training will be used as a quality control measure. The Pacific Northwest Region will continue to utilize the programs administered by Departments of Agriculture in Washington and Oregon. Training and testing of applicators covers laws and safety, protection of the environment, handling and disposal, pesticide formulations and application methods, calibration of devices, use of labels and data sheets, first aid, symptoms of pesticide exposure, etc.

19. Material Safety Data Sheets will be posted at storage facilities, in vehicles, and made available to workers. These provide physical and chemical data, fire or reactivity data, specific health hazard information, spill or leak procedures, instructions for worker hygiene, and special precautions.

Figure II-10

Activity and Implications by Alternative¹

	A	B
Acres managed annually for competing and unwanted vegetation:		
Total	552,100	553,000
Using herbicides	0	59,900
Using mechanical methods	184,600	167,200
Using manual methods	99,000	77,800
Using biological methods	14,800	4,300
Using prescribed fire	217,800	210,000
Receiving no treatment	24,400	19,900
Other	11,500	14,100
Annual Effects and Implications:		
Risk to Workers (Index)	266	318
Risk to Public (Index)	266	288
Risk to Workers (Injury accidents)	1,260	1,082
Emissions from Prescribed Fires (Change from current):		
West-side	36% less	33% less
East-side	33% less	35% less
Long-Term Sustained Yield Capacity²:		
(Change from Alternative B, in million board feet)	95 to 125 less	0
Present Net Value:		
(Change from Alternative B, in million dollars)	468 less	0
Change in Jobs:		
(Change from Alternative B)	1,100 fewer	0

¹Unit definitions, data sources, and assumptions discussed in preceeding text.

²This is the average for all 19 National Forests. The Change will be much greater on some Forests; less on others.

C	D	E	F	G
86,800	380,500	548,600	566,400	579,600
0	26,800	47,900	64,100	76,600
44,900	111,600	166,900	201,000	155,600
17,700	57,800	95,100	80,100	85,700
3,800	18,700	5,900	8,300	6,900
0	125,800	194,000	175,800	215,000
15,600	23,800	24,100	36,100	21,500
4,800	16,000	14,700	11,000	18,300
75	216	290	294	343
75	203	242	262	305
192	760	1,179	1,029	1,156
no burning for veg. management	63% less 60% less	46% less 37% less	63% less 53% less	35% less 31% less
1,000-2,000 less	55-85 less	35-65 less	95-125 less	95-125 more
3,877 less	246 less	132 less	322 less	24 more
21,700 fewer	3,100 fewer	1,400 fewer	3,100 fewer	2,600 more

CODE

10

(1000-2000)
1000000
1000000

1000000

100

1000000000
1000000000

1000000

1000000

1000000

1000000

1000000

1000000

1000000
1000000
1000000

1000000
1000000
1000000

Chapter III

Affected Environment

3

Chapter III

Affected Environment

This chapter describes the existing environment of the Pacific Northwest Region that will be affected by implementing the proposed EIS alternatives. It is a summary of the physical and biological setting of the Region, its social and economic characteristics, and factors affecting the Region's resources.

Introduction

Location and Setting

The Pacific Northwest Region includes the states of Oregon and Washington, as well as portions of two counties in northern California and three counties in western Idaho. (See Figure III-1.) Approximately 500 miles long (north to south), and 380 miles wide (east to west), the Region has a total area of 106 million acres. The Forest Service administers 24.5 million acres, including 19 National Forests and one National Grassland, and assists in the protection and management of 20.5 million acres of other commercial forest lands through cooperative programs with private landowners and state and local governments.

Water, volcanic activity, and glacial events in the Region have created a great variety of landforms, ranging from coastal dunes and flat grasslands to rolling hills and steep, highly dissected hillsides.

The major geological feature in the Region is the Cascade Range, which parallels the Pacific coastline about 100 miles inland. Volcanic peaks over 10,000 feet in elevation regularly punctuate the length of the Cascades, but the main crest averages about 6,700 feet, a significant barrier to cyclonic marine storms. Their "rain shadow" makes the East-side dry.

The Coastal Ranges comprise another major feature west of the Cascades. Parallel to the Cascades, they are much lower in elevation (about 3,000 feet). Forests west of the Cascade crest are wet, with even temperatures characteristic of a marine-dominated climate.

The Coast Range and the Cascades break the Region into four areas that have similar topographic features, climate, and reaction to

Figure III-1
National Forests of the Pacific Northwest Region

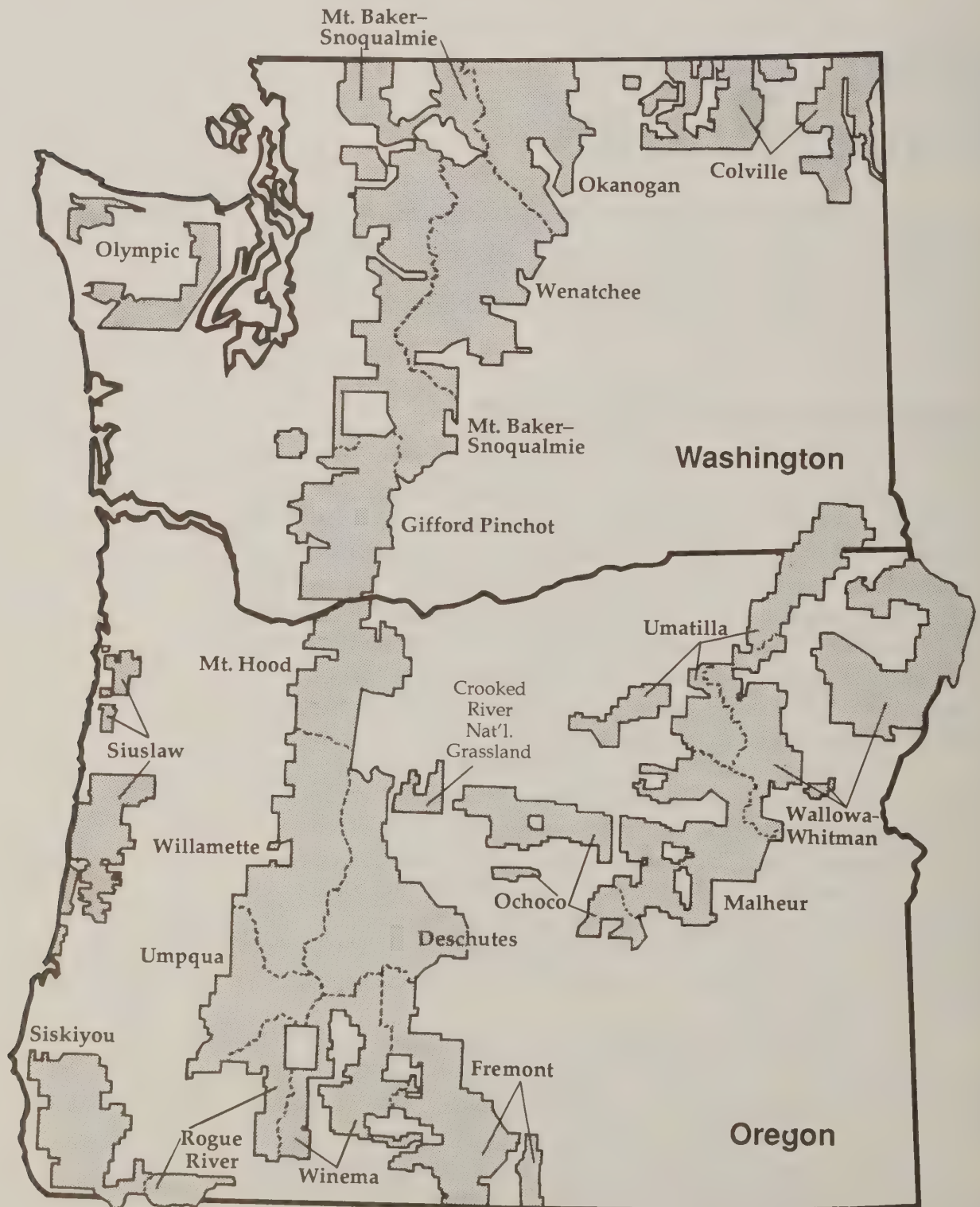
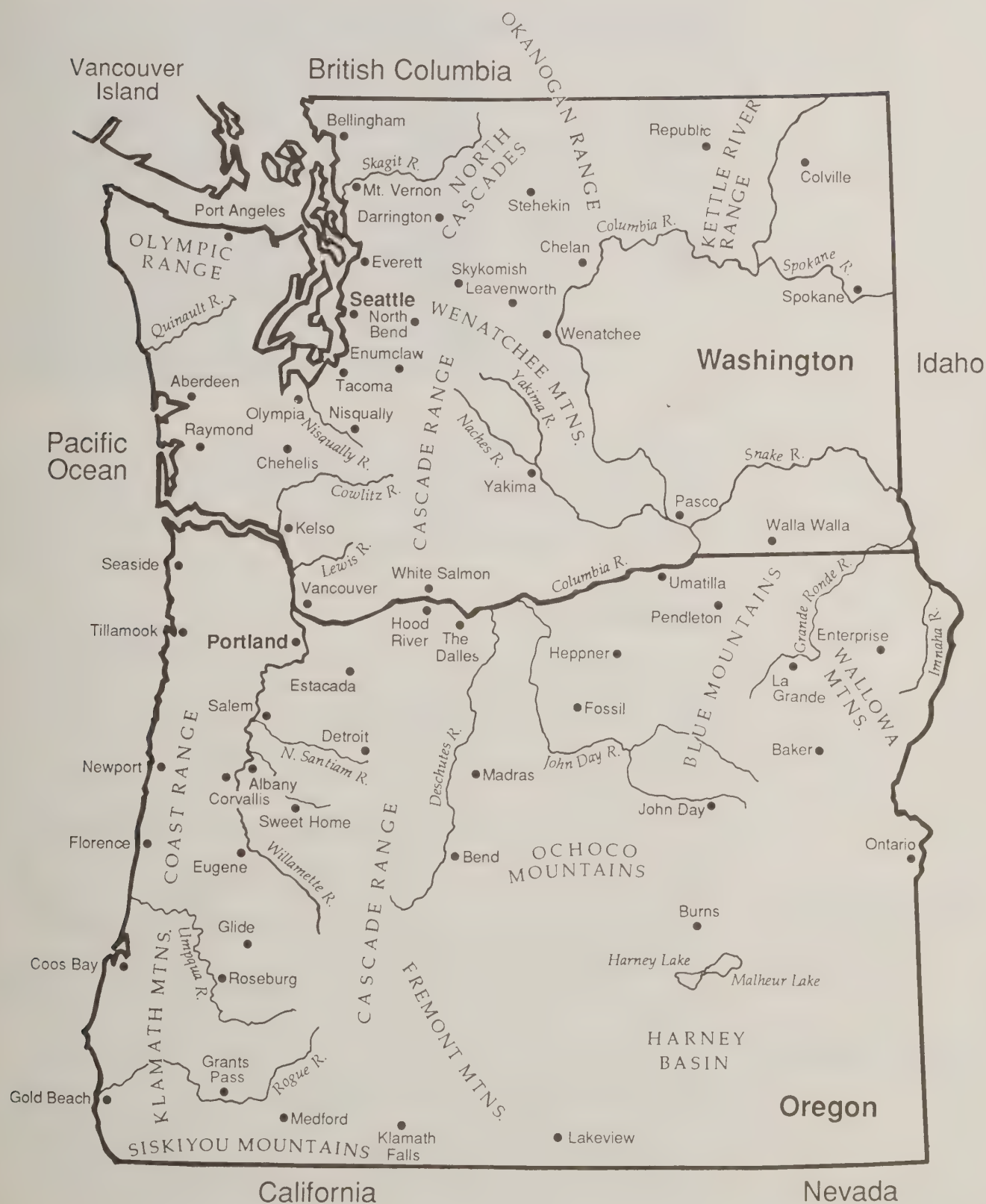



Figure III-2
Geographic Features of Oregon and Washington



management activities (see Figure III-2, and Table III-1 below).

Table III-1

Geographic Subregions of the Forests



<i>Coastal</i>	<i>Western Cascades</i>	<i>Transition</i>	<i>East-side</i>
Olympic	Mt. Baker-Snoqualmie	Wenatchee	Okanogan
Siuslaw	Gifford Pinchot	Deschutes	Ochoco
Siskiyou	Willamette	Winema	Fremont
	Umpqua		Malheur
	Mt. Hood		Umatilla
	Rogue River		Wallowa-Whitman
			Colville

Slopes in the Coastal Forests are generally steep but short, and heavily influenced by the marine climate. The East-side Forests are much less steep, and are in the rain shadow of the Cascade Range. The Transition Forests are a mixture of the two extremes.

Geology

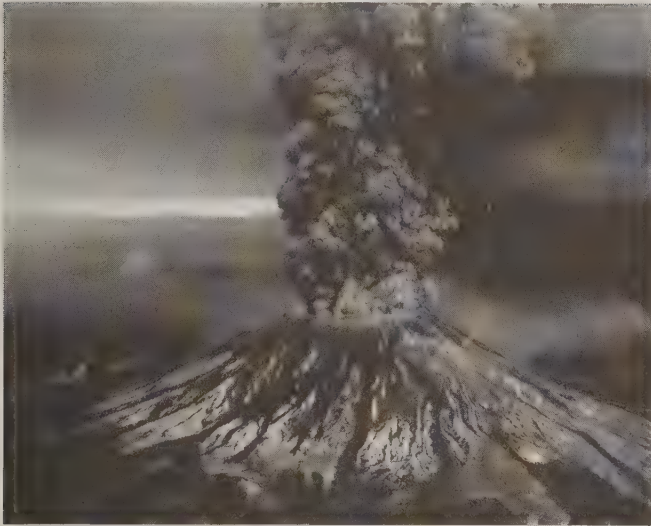
The geology of the Region is dominated by the Cascade and Columbia River vulcanism, and muddled by local intrusions of igneous rocks, faulting, uplift, and metamorphism. The composition, age, and structural integrity of these rocks often determines the course of management.

Sediments of the Coastal Forests are generally porous, erode easily, and are prone to mass movement. The Klamath Geological Province (Siskiyou National Forest) and the Olympic area, however, are much more complex. Geologists are commonly used to interpret local geology for site-specific projects.

The Cascade, Transitional, and East-side Forests are commonly basalt or andesite (extruded fine-grained lava), but a significant portion of the East-side has been covered by ash and pumice during recent volcanic eruptions. The basalts are relatively stable and fertile, but the ash and pumice are infertile and erodible.

The Blue Mountains and Wenatchee Mountains are distinctly more complex than the rest of the East-side Forests. The old limestones, mudstones, and sandstones of the Blue Mountains can be

locally unstable and difficult to manage.



The Pacific Northwest Region exhibits a wide variety of landforms, including active volcanoes such as Mount St. Helens (May 18, 1980 photo).

The Wenatchee Mountains seem to have every known rock type. Moreover, glaciation has mixed and redeposited materials, creating new landforms. The effects of vegetation management are difficult to predict. Averages are almost meaningless; site-specific analysis is essential.

Climate

A parade of winter storms and the summer Pacific high pressure area are the dominant Regional climatic features. The winters are notably wet (typically 80 percent of the total annual precipitation falls in winter), and the dry summers are inconsistently interrupted by localized thunderstorms, particularly in the Transition and East-side Forests.

High rainfall (over 150 inches at the coastal crest), and summer fog keep the Coastal Forests wet most of the year. Temperatures are moderate. Freezing temperatures and snow are experienced only during midwinter.

Cascade Forests receive from 100 inches of annual precipitation on the Rogue River and Umpqua National Forests to over 150 inches on the Gifford Pinchot and Mt. Baker-Snoqualmie National Forests at the north end of the Region. Snow packs last well into summer, feeding many permanent streams. Late spring frost is common.

Coastal Forests

Cascade Forests

Transition Forests

The rain shadow produced by the Cascades reduces the annual rainfall significantly in the Transition Forests. Because the moderating marine influence wanes at the Cascade Crest, average annual temperatures can be 10 degrees Fahrenheit lower than Cascade sites.

East-side

Precipitation on the East-side Forests is less than 20 inches annually in some areas. However, most of the Forests are located on mountain ranges or uplands (the Wallowa Mountains, the Blue Mountains, and the Okanogan Highlands), and precipitation increases with elevation, as does the potential for summer lightning storms. Summers are hot and dry, and frost can occur any time of year.

Soils

Soils take on many of the characteristics of the rock from which they are formed. For example, serpentinites in the Wallowa-Whitman, Wenatchee, and Siskiyou National Forests produce nutritionally unbalanced, unproductive, and unstable soils. The young ash and pumice deposits from the eruptions of Crater Lake and Newberry Crater (and more recently from Mount St. Helens) offer more nutritional balance than serpentinites, but are relatively sterile and erodible.

Soil texture and surface conditions are key concerns because they relate to soil porosity, infiltration, and percolation rates. These variables relate to the fate of chemicals in the soil system and the productivity of the site. However, they must be analyzed on a site-specific basis. Few characteristics are common throughout the Region. Granitic materials and sandstones, however, are often very coarse and porous.

Unstable or potentially unstable soils are extensive on all Coastal Forests and on the Wenatchee and Malheur National Forests (East-side Forests). Instability is often associated with faults and weakly consolidated bedded (layered) sediments, particularly when the bed planes are tilted. Deeply rooted vegetative cover is often the key to maintaining stability and reducing erosion.

Soil depth, texture, and productivity vary throughout the Region. Some of the deepest, most productive forest soils are found in the lower and gentler slopes of the Cascade and Coastal Forests, below the 2,000-foot elevation. Douglas-fir and western hemlock growing on these soils are capable of producing over 200 cubic feet (1,100 board feet) per acre per year.

At mid to high elevations, the soils are frequently moderately deep, stony, and occur on steep to very steep slopes. These soils produce from 50 to 150 cubic feet (280 to 840 board feet) per acre per year.

of wood growth from Douglas-fir, hemlock, and true firs.

In parts of the Transition and East-side Forests, there are many acres of soils derived from coarse-textured volcanic pumice. These areas are characterized by low to moderate productivity for ponderosa pine, lodgepole pine, and true firs at the highest elevations. Wood growth on these sites ranges from 10 to 50 cubic feet per acre per year.

Soils developed from volcanic ash are common in the Blue Mountains of northeast Oregon and in northeast Washington (East-side Forests). These soils usually are mixed with soils from glacial till (mixed, unsorted material left by glaciers) in northeast Washington, and with residual and colluvial soils from basalt in the Blue Mountains. These soils are moderately productive, have high water storage potential, and support inland Douglas-fir and associated species. The basalt-derived soils in the Blue Mountains usually range from medium to fine in texture, and are shallow to moderately deep. Ponderosa pine is the dominant tree vegetation. Wood growth on these soils ranges from 10 to 110 cubic feet per acre per year.

On ash-derived and loess-derived soils (which are more common), grand fir is the dominant climax tree species (Johnson and Simone 1987; Hall 1973).

As soils age, they accumulate organic debris (needles, leaves, limbs, dead animals, and, less often, tree trunks) which is gradually incorporated into the soil. This debris is an important factor affecting long- and short-term site productivity. Referred to as "duff," it protects the soil surface; provides food and habitat for small mammals and microorganisms; and slowly releases nutrients for plant growth. The status of this complex soil ecosystem is a major concern in all vegetation management activities.

Fire

Fire, both natural and human-caused, played a significant role in the evolution of Pacific Northwest ecosystems. Fires influence the physical and biological forest environment through effects on both individual species and communities. The prevalence of many plant species with special adaptations to fire provides convincing evidence that fire is an integral part of many Pacific Northwest ecosystems. Typical fire adaptations include cone serotiny (cones that require heat to open and release seeds), the ability of species to sprouting after top kill, and heat-induced germination of seeds which have the ability to remain viable in the soil for long periods.

Wildfire history varies throughout the Pacific Northwest depending upon an area's vegetation (fuel), topography, climate, and

the coincidence of ignitions with weather and fuel moisture conditions that allow a fire to burn. Wildfire regimes are defined by wildfire frequency, severity, and size. Seven fire regimes are recognized:

- 0 — no natural fires
- 1 — infrequent, light surface fires
- 2 — frequent, light surface fires
- 3 — infrequent, severe surface fires
- 4 — short return-interval crown fires
- 5 — long return-interval crown fires
- 6 — very long return-interval crown fires

Historical Trends

Regime number 6—very long return-interval crown fires—was the pre-settlement fire regime of the Coastal and Cascade forests. Regimes 4 and 5 were characteristic of the Transition Forests and the interior mixed conifer stands of the East-side Forests. Regime 2—frequent, light surface fires—were characteristic of East-side ponderosa pine stands.

The value of fire has been recognized for thousands of years. Native Americans deliberately burned the land to ease travel, improve hunting, and facilitate food gathering. Grasslands of the Willamette and Tualatin valleys were burned annually to improve the harvest of wild wheat. Early European settlers recognized the value of fire for thinning forests, reducing wildfire hazard, improving travel, and stimulating the growth of desirable plant species.

Lightning-caused wildfires are common principally in the Transition and East-side Forests. However, most large wildfires are human-caused. In the Coastal and Cascade Forests, heavy fuel loads, drought, warm, dry east winds, and human activity conspired to produce wildfires of extreme severity. The earliest of the great human-caused wildfires in Oregon burned 500,000 acres between the Siuslaw and Siletz Rivers in the 1840's (Pyne 1982).

Deliberate use of fire declined early in the 20th century as a result of a growing interest in conservation and a desire to reduce smoke. Catastrophic wildfires in the late 19th and early 20th centuries led to fire being regarded as a destroyer that should be prevented at all cost. Modern forest fire protection began in the wake of these fires. In an attempt to eliminate destructive wildfires, benefits derived from periodic burning of grasslands and forests in the "frequent, light surface fire" regime and shrublands in the "infrequent, severe surface fire" were given up.

The era of fire exclusion has had a considerable impact on some fire-dependent Transitional and East-side Forest ecosystems. Periodic fires are essential to the functioning of these ecosystems. As a result of fire exclusion, successional patterns have been altered; nutrient cycling



Fires, both natural and human-caused, play a significant role in the evolution of Forest ecosystems within the Pacific Northwest Region.

has been delayed; and vegetative debris has increased to unnatural levels. In such instances, fire exclusion can be considered more of a disturbance than fire itself. Fire exclusion has set the stage for devastating wildfires in many areas.

The goals of fire management in the Forest Service in the Pacific Northwest Region are to reduce wildfire damage and improve the natural resources with prescribed fire. Fire management is subdivided into two functionally distinct areas: wildfire protection; and fire use. Wildfire control consists of fire prevention, detection, and suppression. Fire use consists of prescribed burning to reduce wildfire hazard and to affect vegetation development.

The current Regional wildfire policy emphasizes total suppression of all wildfires in a timely, cost-efficient, and safe manner. Suppression strategies are based on objectives designed to minimize both suppression cost and resource damage. Strategies range from immediate control (minimizing acres burned) to more indirect control through containment and confinement (minimizing cost).

During the 15-year period 1972 through 1986, 24,494 fires burned 257,000 acres (1 percent of the Region's National Forests). Lightning fires accounted for 43 percent of the fires and 32 percent of the acres burned. Human-caused fires accounted for 57 percent of the fires and 68 percent of the acres burned.

Wilderness fire policy has changed considerably since the mid 1970's. Special recognition of the role of natural fire in creating the conditions for which some wildernesses were established has prompted managers to take a moderate suppression position. Specifics of wilderness fire programs are included in individual Forest Plans.

Prescribed burning has been a common method for disposing of logging slash since the early 1940's. Recognizing the ecological benefits of fire, the modern-day land manager is using prescribed fire for a variety of other reasons (see the section on burning methods in Chapter II).

The effects of prescribed fire can differ markedly from the effects of wildfire. Where a prescribed fire would benefit a partially cut stand, a wildfire could be very destructive. The prescribed fire would reduce the amount of logging slash; possibly expose some mineral soil to seed produced by the residual trees; and stimulate the growth of selected species for wildlife browse. The prescribed fire could also be planned to minimize impacts on air quality.

A wildfire, on the other hand, might kill all or part of the residual trees and remove most or all of the protective litter and duff

Current Conditions

Wildfire Protection

Fire Use

layers, leaving the soil exposed to the erosive forces of wind and water. Reforestation of the damaged site could take many years.

Controlled burning has been a common method for disposing of logging slash since the early 1940's. Such burning will be less common in future years, due to better utilization of slash and an increased emphasis on maintaining high air quality.



Fuels are treated to reduce the severity of wildfires. Fuels are either activity-generated or occur naturally. Activity fuels result from logging, forest stand thinning, and road construction. Natural fuels result from processes such as blowdown and insect and disease mortality.

Besides burning, fuels are treated using mechanical methods (crushing, machine piling (PUM), and yarding of unmerchantable material to the landing site (YUM)). Manual methods—hand piling, slashing, and scattering—are also used. Promoting better utilization also achieves a great deal. Residues can be used for firewood, fence posts, and to generate steam and electricity.

In 1986, prescribed burning was done on 204,792 acres. Forty-five percent of the acres were broadcast or underburned; fifty-five percent were pile burned. Treating logging slash accounted for 78 percent of the acres burned. The remaining 22 percent included acres burned to improve wildlife habitat and range, and to reduce natural fuels.

Forest Service policy now allows prescribed burning in designated wildernesses with the approval of the Regional Forester. To date, no prescribed burning using “planned” ignitions has been done in the Region’s Wildernesses.

Future Trends

Burning of activity-generated fuels will be less common in future years. The decrease will be due to better utilization; the fact that less slash will be produced in the course of managing “cleaner” second-growth stands; and that air quality considerations will force managers

to use other methods where feasible.

Prescribed burning of natural fuels, principally on the East-side Forests, is expected to increase. In keeping with the Region's policy to use prescribed fire where burning will benefit the ecosystem, it will be increasingly used to improve range and wildlife habitat, encourage fire-dependent plant species, and preserve wilderness ecosystems.

Cooperating agencies include the Bureau of Land Management, Bureau of Indian Affairs, Washington Department of Natural Resources, and the Oregon State Department of Forestry.

Cooperating Agencies

Air

Air is an integral part of the forest environment. Its character directly affects plant and animal habitat, and contributes to the scenic and recreational attributes of the Pacific Northwest Region. Forest Service management activities can directly affect air quality, both on and off National Forest lands. Conversely, the air quality of National Forest lands can be affected by off-Forest activities of the general public.



Air quality varies widely from one part of the Pacific Northwest Region to another due to differences in population levels, industrial activity, topography, and meteorology. The Three Sisters Wilderness Area, shown here, is designated a Federal Class I area, to be protected from any but the smallest degradation of air quality.

The quality of the air varies from one part of the Pacific Northwest to another due to differences in population levels and concentration, industrial activity, topography, and meteorology. Air quality is strongly influenced by the local weather; temperature inversions that trap smoke (and other classes of emissions) occur frequently in the late summer and early fall, particularly west of the Cascades. In the fall and winter, smoke produced by people using wood to heat their homes is a major pollutant.

Current evidence indicates that particulate emissions from the burning of vegetation are of most concern. Particulates are aggregate matter, composed of solids or liquids (other than water). These are suspended in (or fall through) the atmosphere (Prescribed Fire and Fire Effects Working Team 1985).

Smoke particulates affect visibility, serve as sorption surfaces for harmful gases, and aggravate respiratory conditions in susceptible individuals (Sandberg et al. 1978). Sorption refers to the ability of a particle to bond another substance either to its surface or interior.

Physical characteristics of particulate matter vary greatly. Particulate air pollution consists of particles as large as 100 microns in diameter (Department of Environmental Quality 1985).

Particles greater than 10 microns in diameter fall out of the atmosphere fairly rapidly, and can only be detected within a short distance from their source. Smoke from the combustion of woody fuels is made up of particulates that, because of size (90 percent are smaller than 2.5 microns), can be transported long distances. This "fine particulate matter" has the greatest potential to impact visibility and human health. Figure III-5 shows the portion of particulates from forestry burning.

Historical Trends

Smoke has been a matter of more than casual note in the Pacific Northwest for many years. Newspaper writers in the late 1800's commented on "the immense volumes of smoke created by vast fires." Smoke was blamed for a variety of "seasonal distempers and diseases." Prior to the advent of industrial-scale logging, the chief argument for wildfire control was protection of the populace from smoke (Pyne 1982).

Until the late 1970's, most slash burning was done in the fall; thousands of tons of logging debris were burned during a very short period. Serious air pollution episodes often occurred because the weather at that time of year frequently allowed smoke to accumulate in the Puget Trough, Willamette Valley, and Rogue Valley.

Laws and Regulations

Legislation to protect the Nation's wilderness and national park lands began with the National Park Service Enabling Act of 1916, supplemented by the Wilderness Act of 1964. These and subsequent amendments set aside areas to be preserved in their natural "pristine state," unimpaired by human activities.

National concern for air quality in the 1960's led to the passage of the Clean Air Act of 1964 which was amended in 1970, and again in 1977. The 1977 amendments specifically addressed the need to preserve and protect the quality of the air in the relatively clean rural and remote areas. In the 1977 amendment, Congress directed that all areas of the country be placed into one of three classifications:

Class I, areas where anything but the smallest degradation of air quality would be socially unacceptable;

Class II, areas where moderate degradation of air quality would be socially acceptable; and

Class III, areas where a considerable degradation of air quality would be socially acceptable.

All National Parks and wildernesses larger than 6,000 and 5,000 acres (respectively) existing on August 7, 1977 were designated Class I



The Nation's wilderness, such as the Alpine Lakes Wilderness Enchantment Area shown here, are preserved in their natural, pristine state.

areas. The remainder of the country was designated Class II.

At this time no areas have been redesignated Class III. The importance and value of the Region's Class I areas lie in their intrinsic beauty, their importance as a tourist attraction, and as a recreational resource for the people of Oregon and Washington.

Twenty Class I areas are located in Oregon and Washington (Table III-3). Sixteen are National Forest wildernesses and four are National Parks.

Table III-2
Class I Areas in Oregon and Washington

<i>Oregon</i>	<i>Washington</i>
Mt. Hood Wilderness	Mount Rainier National Park
Eagle Cap Wilderness	North Cascades National Park
Hells Canyon Wilderness	Olympic National Park
Mt. Jefferson Wilderness	Alpine Lakes Wilderness
Mt. Washington Wilderness	Glacier Peak Wilderness
Three Sisters Wilderness	Goat Rocks Wilderness
Strawberry Mountain Wilderness	Mount Adams Wilderness
Diamond Peak Wilderness	Pasayten Wilderness
Crater Lake National Park	
Kalmiopsis Wilderness	
Mountain Lake Wilderness	
Gearhart Mountain Wilderness	

Congress directed all federal land managers to comply with all Federal, state, and local air quality regulations. In the "prevention of significant deterioration" (PSD) sections of the Clean Air Act, Congress directs federal land managers to protect "air quality-related values" in Class I areas. An air quality-related value is a feature or property of an area that is affected in some way by air contaminants. The only air quality-related value specifically identified in the Clean Air Act is visibility.

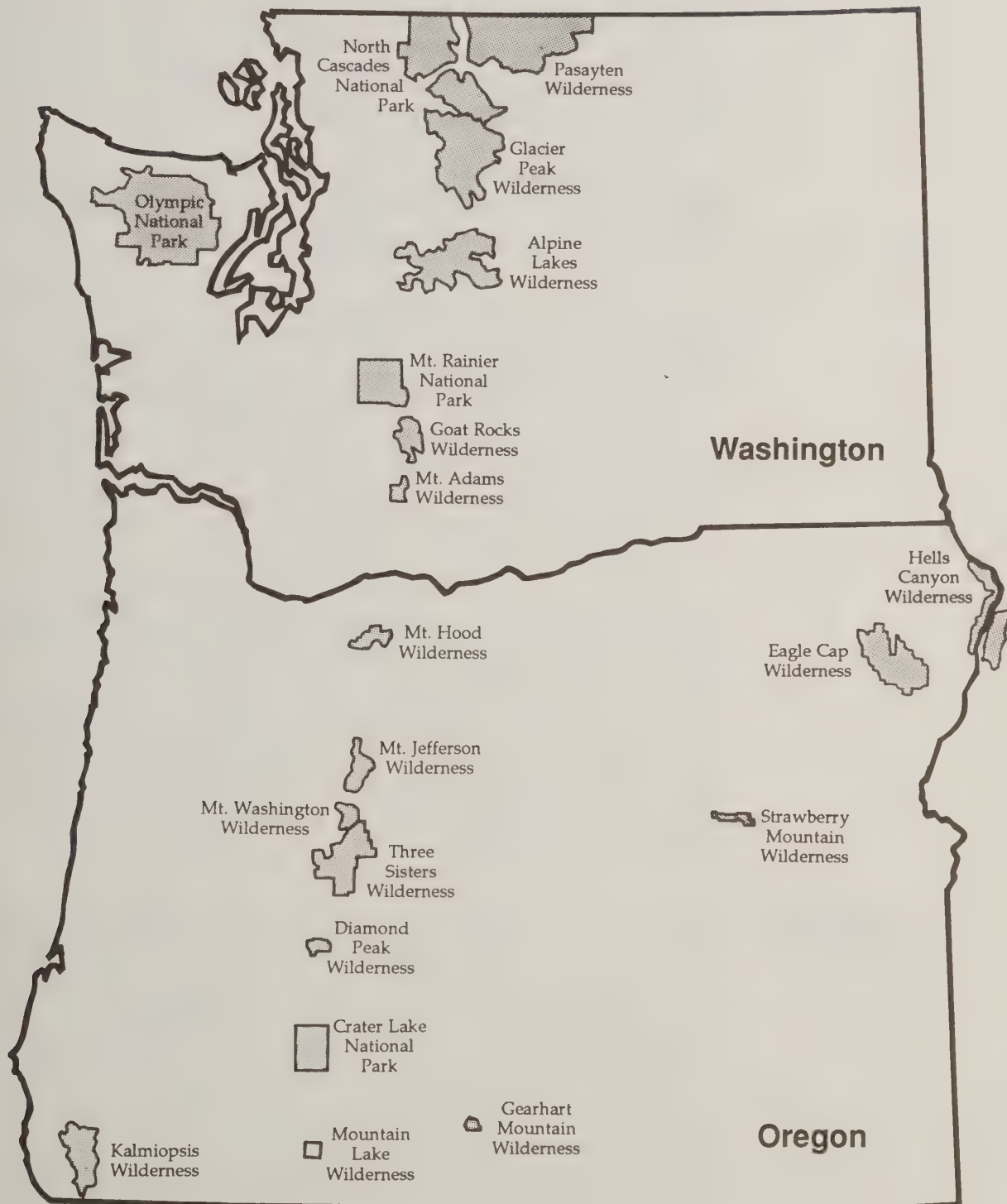
It is important to note that the State of Oregon has determined that forestry burning is regulated under the prevention of significant deterioration provisions of the Clean Air Act. California and Washington have classified forestry burning as a "temporary source", hence not subject to the prevention of significant deterioration regulations. It is legally within the State of Oregon's prerogative to make that determination.

Section 169A of the Act sets "...as a national goal, the prevention of any future and the remedying of any existing impairment of visibility in mandatory Class I Federal areas in which impairment results from man made air pollution."

Both the Environmental Protection Agency (EPA) and the states were given responsibilities intended to assure achievement of that goal.

The Environmental Protection Agency, in response to requirements of the Clean Air Act, developed National Ambient Air Quality Standards (NAAQS) for six air pollutants: carbon monoxide, nitrogen

Figure III-3
Class I Areas of the Pacific Northwest



dioxide, sulfur dioxide, lead, ozone, and particulate matter. The standards were established to protect public health and welfare. Ambient standards are of two types: primary standards to protect public health; and secondary standards to protect public welfare.

The states are assigned the primary responsibility for developing and implementing regulations—detailed in their State Implementation Plans (SIP's)—to assure that the National Ambient Air Quality Standards and other standards are met. States may adopt air quality standards more stringent than National Ambient Air Quality Standards.

Smoke Implementation Plans include programs to assure the timely clean up of excessively polluted areas. Clean areas are called “attainment” areas; excessively polluted areas are called “nonattainment” areas.

An area may be classified as attainment for several criteria pollutants, but classified as nonattainment for others.

Washington and Oregon both have Smoke Management Plans detailing the procedures and lines of authority for carrying out prescribed burning. In Oregon, the Oregon Department of Forestry is the responsible agency; in Washington, the Department of Ecology and Department of Natural Resources share the responsibility. In both states, the objective is to prevent pollution episodes caused by forestry burning.

Numerous areas in the Region are classified in the Smoke Management Plans as “designated areas” (Figure III-4). Designated areas are typically population centers, but may be other areas requiring protection under State or Federal air quality laws or regulations.

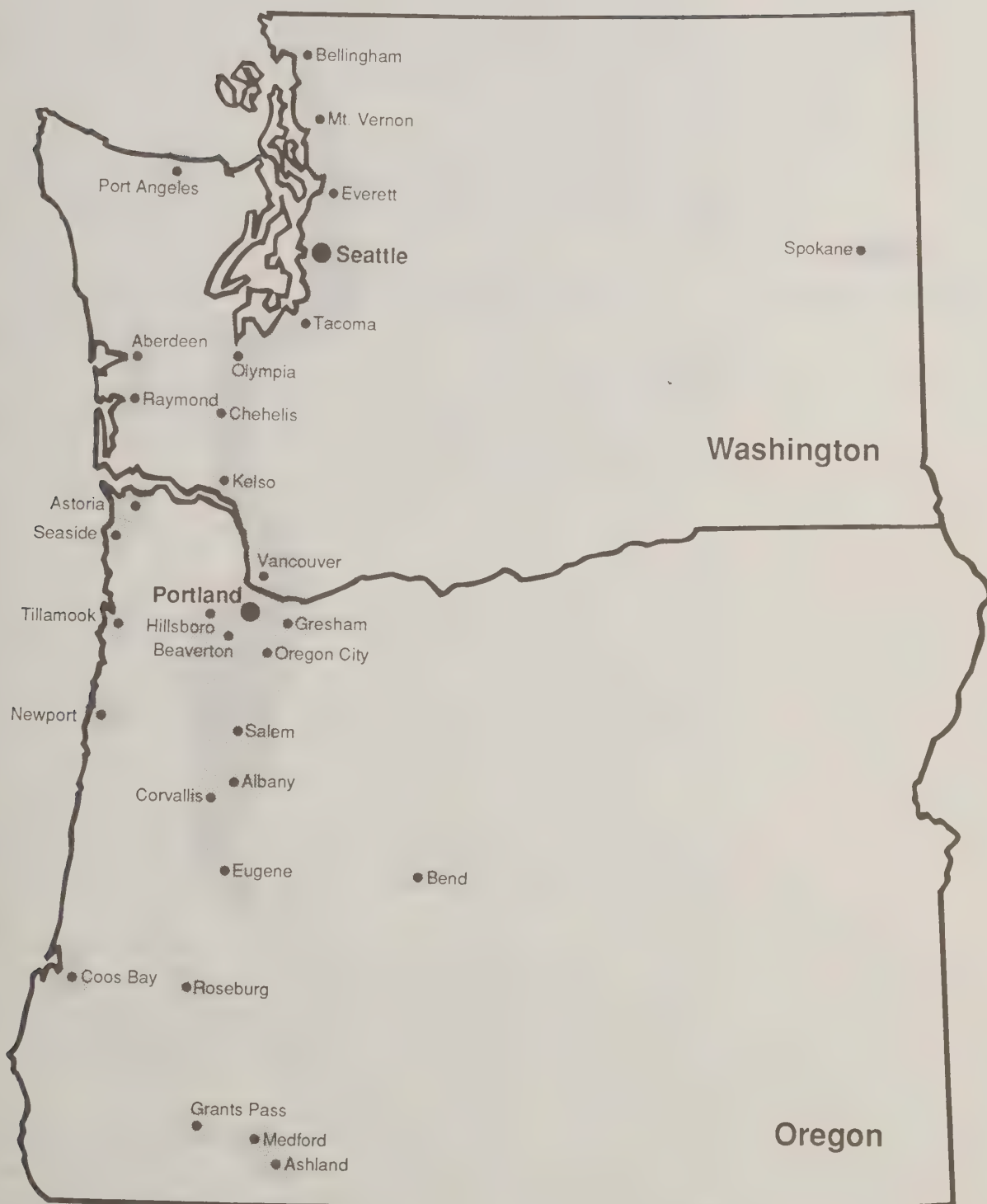
A “smoke-sensitive area” is an area that would be negatively impacted by smoke, but is not necessarily a designated area. For example, orchard areas in northeastern Washington are smoke-sensitive areas. They are treated as designated areas during daylight hours in August and September.

Current Conditions

Oregon and Washington have amended their Smoke Implementation Plans to address the visibility improvement/protection issue. Both contain provisions to regulate prescribed burning to reduce emissions, thereby ameliorating the impact of smoke on visibility. Prescribed burning is restricted in Oregon west of the Cascade Mountains during the high visitor and recreation use period of July 4 through Labor Day. Washington will restrict burning on weekends and during “visibility important” days during that same period.

Oregon and Washington have both established total suspended particulate (TSP) reduction objectives. Washington's 1990 goal is to

Figure III-4
Designated Areas in Oregon and Washington



reduce emissions generated by prescribed burning in western Washington to a level 35 percent below the 1976-1979 baseline period. Oregon intends to reduce prescribed fire smoke in western Oregon to a level 50 percent below the 1976-1979 baseline by 2000.

Currently, there are three nonattainment areas in Oregon for particulate matter (TSP): Portland, Eugene-Springfield, and Medford. Control strategies designed to reduce ambient particulate levels are in effect in all three areas (Oregon Department of Environmental Quality 1985).

Vancouver, Seattle, Tacoma, Renton, Kent, and Longview are nonattainment areas for particulate matter in western Washington. In eastern Washington, Spokane and Clarkston are classified as nonattainment areas for particulate matter. Control strategies designed to reduce ambient particulate levels are in effect in all eight areas.

A contaminant is any unnatural substance released into the atmosphere. A contaminant may also be a natural substance, if its concentration significantly exceeds the normal value (Prescribed Fire and Fire Effects Working Team 1985). An air pollutant is an air contaminant that is potentially harmful. Air pollutants include dust, gas, particulate matter (smoke), and acids.

Smoke from prescribed burning on forest and agricultural lands has the potential for a significant impact on air quality. The area and amounts of slash treated with prescribed fire on National Forest and other public lands west of the Cascades has decreased in recent years, primarily because of a commitment by public agencies to improve air quality. Conversely, there has been a large increase in the use of prescribed fire on private lands (Sandberg 1986). Emissions from prescribed burning on the Coastal and Cascade Forests are now 30 percent less than during the period 1976-1979 (Sandberg et al. 1985).

The decrease has been achieved with the use of "state-of-the-art" emission reduction techniques—burning when the moisture content of large, woody fuels is high; use of rapid ignition techniques; and more utilization of what would have been left as slash just a few years ago.

During the 1976-1979 baseline period, biomass consumption averaged 60 tons per acre in western Oregon, and 58 tons per acre burned in western Washington. In 1984, biomass consumption averaged 44 and 37 tons per acre, respectively (Sandberg 1986). Equivalent baseline information cannot be developed for the areas east of the Cascades in Oregon and Washington.

Visibility in the Region is currently monitored by the states to determine the extent and causes of visibility impairment in Class I areas. Visibility in Class I areas is frequently impaired by uniform haze during the summer and fall months. Beck and Associates (1986)

reports that during summer months, perceptible human-caused impairment within the Mt. Hood and Central Cascade wildernesses and Crater Lake National Park occurs 17 percent, 33 percent, and 4 percent of the daylight hours, respectively.

Slash burning accounts for 50 percent of the fine particle pollution (particles with diameters less than 2.5 microns) in the Mt. Hood Wilderness. In the Central Oregon Cascades wildernesses, slash burning accounts for about 30 percent of the fine particle pollution.

All of the designated areas, except Spokane and Bend, are west of the Cascades. The orchard areas of Okanogan, Chelan, Douglas, Kittitas, Benton, and Yakima counties in eastern Washington are classified as smoke-sensitive areas.

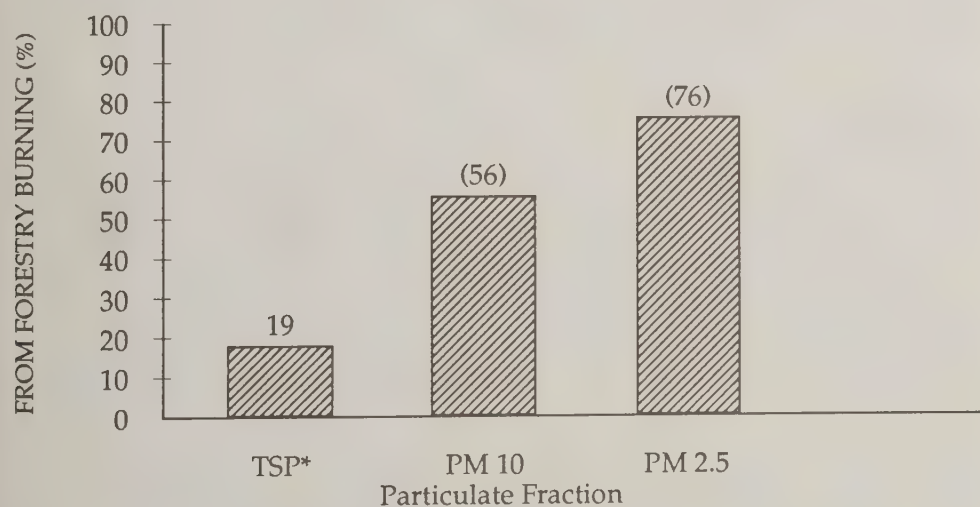
Public demand for clean air will certainly persist, if not increase. Air quality regulations may become more restrictive, further limiting the use of prescribed fire.

The Environmental Protection Agency has proposed revising the National Ambient Air Quality Standards for particulate matter to specifically address particulates that may endanger human health. The current standard addresses particulates on a total mass basis, though

Future Trends

Figure III-5

Oregon Proportion of Particulate From Forestry Burning (Annual Basis).



* TSP—Total Suspended Particulates
PM 10—Diameter \leq 10 microns
PM 2.5—Diameter \leq 2.5 microns

generally only particles smaller than 50 microns in diameter are included.

The revised standard will address both inhalable and respirable particulates. Inhalable particulates generally are deposited in the upper portion of the human respiratory system, and may be expelled. Respirable particulates are likely to be deposited in the pulmonary tract and retained in a person's system for a relatively long time. Inhalable particulates are less than 10 microns in diameter (PM-10); respirable particulates are less than 2.5 microns in diameter (PM-2.5).

The smaller size specified by the proposed standards will dramatically increase the significance of prescribed burning emissions. For example, in Oregon, prescribed burning produces approximately 19 percent of all particulate matter, but is responsible for 56 percent of all PM-10 emissions, and an even greater proportion of PM-2.5 emissions (Haddow 1983). See Figure III-5.

In Oregon's principal West-side populated areas, residential heating with wood accounts for 76 percent of the fine (PM-2.5) particulates; forestry (prescribed) burning, 23 percent; and field burning 1 percent. Those values are year-long averages; seasonally, the distribution is considerably different (Oregon DEQ 1987).

A further restriction on the use of prescribed fire will result if recently made additions to the wilderness system are reclassified Class I by the states.

Cooperation With Other Agencies

Agencies with responsibilities in air quality management include the Oregon Department of Environmental Quality, Washington Department of Ecology, Oregon State Department of Forestry, and Washington Department of Natural Resources.

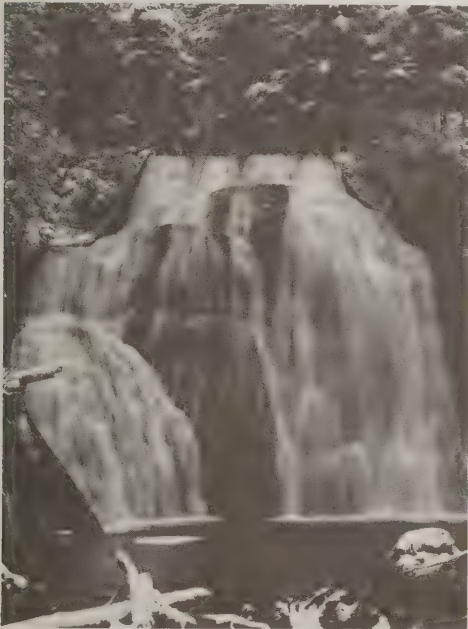
Water

Current Conditions

The National Forests occupy 23 percent of the land in the Pacific Northwest, yet 44 percent of the region's water supply originates on National Forest land. There are 112,000 miles of streams and approximately 216,000 surface acres of lakes and reservoirs which produce 75 million acre-feet of water. There are thousands of acres of wetlands and floodplains which provide unusually diverse habitat, particularly where the riparian and terrestrial ecosystems meet. The dynamic nature of this interface (changing of water levels and freezing and thawing) allows an unusually high number of species to survive.

About six million acres, approximately one quarter of National

Forest lands, are managed specifically as domestic watersheds. About 800,000 acres are managed according to formal agreements with 15 municipalities. Many of the agreements list specific restrictions. For example, the cities of Ashland, Medford, Portland, Seattle and The Dalles prohibit or severely restrict the use of herbicides. There are approximately another 60 watersheds managed for individual use, ski areas, etc., which have no formal agreement. Other uses include irrigation, hydroelectric generation, and fish production.



The management of vegetation and soils in each watershed plays a key role in determining the quality and quantity of water produced by the National Forests.

The quality and quantity of water produced by the National Forests is dependent on the management of vegetation and soils in each watershed. Managing streamside vegetation, roadside vegetation (particularly during and shortly after construction), and vegetation in harvest units is key to maintaining water quality.

Sediment is the primary polluting factor reducing water quality. Erosion from road construction, harvesting, landslides and natural sloughing of streambanks is the major source. Information is lacking about the relative contribution of vegetation management activities.

Water quality in National Forest streams is generally excellent. For example, water from the Bull Run watershed that supplies the City of Portland, requires little treatment.

Federal agencies with responsibilities involving water resources include the Environmental Protection Agency, Army Corps of Engineers, United States Geological Survey, and the Soil Conservation Service.

Water Quality

Cooperation With Other Agencies

Washington State agencies include the Washington Department of Game, Washington Department of Ecology, Washington Department of Fisheries, and Washington Department of Natural Resources.

Oregon State agencies include the Oregon Department of Environmental Quality, Oregon Department of Forestry, Oregon Water Resource Department, Oregon Department of Lands, and Oregon Department of Fish and Wildlife.

The North Coast Regional Water Quality Control Board (California) and the California Department of Fish and Game are also involved with management of water resources in the Region.

Vegetation

Background

Vegetation is often described by layers. The tree overstory is usually the most dominant vegetative feature, followed by the tree understory, shrubs, herbs, grasses, nonvascular plants (such as moss, lichens, and fungi) and small plants that live in the top layers of the soil.

Forest vegetation is often described in layers. The tree overstory is usually dominant, followed by the tree understory, shrubs, herbs, grasses, and nonvascular plants (such as moss, lichens, and fungi) and small plants that live in the top layers of the soil.



All layers are important to a fully functional ecosystem, but traditionally, vegetative provinces are named after the most visible layer. In the Pacific Northwest, Douglas-fir often visibly dominates the overstory, but is commonly replaced by shade tolerant, trees in the understory. These shade tolerant, “climax” trees are indicative of the long-term climate and the site’s productive potential. Most ecological vegetation classification systems are based on such climax vegetation.

Shrubby vegetation is often the “target” (the specific species causing unacceptable damage) of control activities, but all other layers are also of concern. Trees, particularly noncommercial hardwoods—and western juniper, where grass is the favored species—can also be

targets. Grasses can also be targets, particularly on dry sites where they compete with tree seedlings for water. The majority of noxious weeds are herbs, many from the sunflower family, a highly adaptive group. See the section on noxious weeds.)

Nontarget species (associated vegetation) are also of concern. Each species adds to the diversity of the ecosystem. Diversity provides structure and composition for animal habitat, resistance against epidemics, and resilience after disturbances. Each species plays a unique role in the ecosystem and contributes to overall site productivity. The objective is to maintain the diversity in all layers. Thus, the objective of vegetation management has always been control rather than elimination, except where noxious weeds are involved.

Threatened, sensitive, and endangered species are of special concern. (See the section on Threatened, Sensitive, and Endangered Plant Species.)

Endangered species are Federally recognized. The Regional Forester has emphasized the need to prevent damage to any populations of endangered species. The objective is to actively manage to maintain or enhance existing populations. More information can be found in Forest Service Manual sections 2605 and 2670.5.

The following section briefly describes common vegetation in the four subregions (Coastal, Cascades, Transition, and East-side) described in the beginning of this chapter.

Douglas-fir, western redcedar, several true firs, western hemlock, and Sitka spruce characterize the Coastal subregion, except for the Siskiyou National Forest, where tanoak is common and dominant. Salmonberry, salal, rhododendron, vine maple, and evergreen huckleberry commonly dominate the shrub layer. Swordfern, and in places, brackenfern are the characteristic herbs.

Target Species. All of the shrubs mentioned above can be targeted for control. Salmonberry and vine maple are the most important competitors. However, tanoak, alder, and thimbleberry are serious problems on specific sites. Tansey, gorse, and the thistles are also targets for control.

Associated Vegetation. Hemstrom and Logan (1986) list 25 shrubs and 48 herbs and grasses in their Plant Association and Management Guide for the Siuslaw National Forest. Little is known about the competitive ability of many of these species. Information concerning their ecological role in maintaining long-term productivity is also lacking. Careful monitoring and research is needed.

The Siskiyou Mountains (in the southern part of the coastal area) have an unusually high number of sensitive species (112) that must be considered when planning and executing vegetation manage-

Coastal Vegetation

ment projects. Major commercial species in the Cascade Range include Douglas-fir, true firs, and other conifers.

Cascade Vegetation

Western hemlock is the dominant climax species on the western slopes of the Cascades. It is replaced gradually by Pacific silver fir at the higher elevations, and ultimately, by mountain hemlock near timberline. A subalpine zone is also commonly found in this subregion. Many of the Coastal shrubs, such as rhododendron, vine maple, and salal are also common on the west slopes of the Cascades. Dwarf Oregon grape is extremely common throughout the Cascades. At the high elevations, gooseberry and several species of huckleberry are most common.

Target Species. Vine maple, ceanothus, and Pacific rhododendron are often considered for control. On some sites they can be as competitive as their Coastal counterparts. Except for a few sedges, competition at higher elevations seems to be less of a problem. Thin-leaved and Alaska huckleberry are uncommon as target species. Tansey, thistle, and skeletonweed are common noxious weeds.

Associated Vegetation. The Cascades are rich with shrub, herb, grass, and nonvascular species. The Plant Association and Management Guide for the Western Hemlock Zone (Topic, et al. 1986) and the Preliminary Plant Association and Management Guide (Hemstrom et al. 1985) for the Willamette National Forest present a detailed description of the vegetation in the Cascade area.

East-Side Vegetation

The East-side varies from forest to grassland. Douglas-fir, white fir, ponderosa pine, subalpine fir, lodgepole pine, grand fir, mountain hemlock, and juniper forests are found on the mountainous uplands. They grade into shrub-dominated systems where big sagebrush and bitterbrush are common. Bluebunch wheatgrass is dominant on many of the grasslands. See the section on Rangelands in Chapter IV and Appendix F for more information.

Target Species. Western juniper is often a major target species. It reduces grass and forage, decreasing the amount of utilizable range. Ceanothus and manzanita can also be quite competitive, but generally there has been less use of vegetation management on the East-side than in the Cascades or Coastal areas.

Noxious weeds are a serious threat to range production. There are a significant number of cattle poisoned each year (see the sections on noxious weeds). Many of these weeds are in the sunflower family, a group known for its ability to aggressively invade disturbed or slightly disturbed ground.

Noxious weeds that invade pastures or range are susceptible to

selective herbicides that have little chance of damaging nontarget species.

Associated Vegetation. The Blue Mountains and the Wenatchee Mountains have a significant number of sensitive species to be considered when planning vegetation management activities.

Douglas-fir, ponderosa pine, subalpine fir, western larch, silver fir, and aspen are common on forested areas. Bitterbrush, huckleberry, ninebark, and Oregon boxwood are common shrubs. The herb layer is commonly composed of twinflower, heartleaf arnica, and yarrow. Pinegrass, Idaho fescue, bluebunch wheatgrass, cheatgrass, bluegrass, and a variety of sedges occur in the grass (and grass-like) layer. More information can be found in the Region's Ecology Series publications available at the Regional Office.

The Transition Forests have a mix of forest, shrub, and grassland types typical of both sides of the Cascades. Mountain hemlock and lodgepole pine forests are characteristic of high elevations and pumice/ash parent materials. Grand fir and ponderosa pine are common at mid elevations on all types of soils. Western Larch and subalpine fir can also be locally important species.

Target Species. Snowbrush ceanothus is an important target species, particularly near the Cascades. It occurs on productive sites after site preparation and burning. Greenleaf manzanita can also be competitive. Both species invade after disturbances such as timber harvest, burning, and mechanical scarification.

Associated Vegetation. There is a rich mix of East-side and Cascade species in the Transition Forests. More information can be found the Region Six Ecology Series plant association and management guides available at the Regional Office.

Forests

Much of the forested land within the National Forests of the Pacific Northwest Region is among the most productive in the world. Roughly 90 percent of the National Forest lands are forested. Of this, approximately 76 percent (18.5 million acres) has a productivity level equal to or exceeding 20 cubic feet per acre per year. Timberlands have traditionally divided into two broad subregions: the Coastal and Western Cascades subregion and the East-side and Transition subregion.

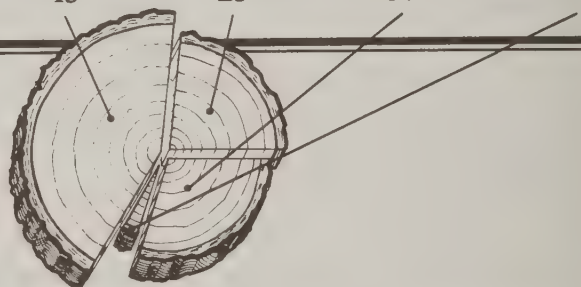
Transition Vegetation

Current Conditions

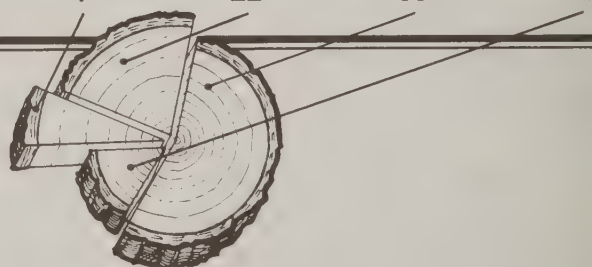
Table III-3

Timber Productivity on Available Commercial Forest Lands In the Pacific Northwest Region
(Cubic Feet per Acre per Year)

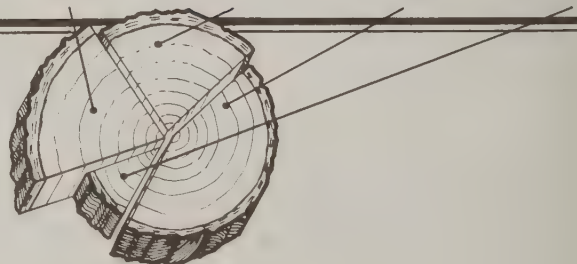
Coastal and Western Cascades Subregion				Total Acres: 6,658,000
Productivity Class	120+	85-119	50-84	20-49
Thousand Acres	2,825	1,552	1,991	290
Percent	43	23	30	4



East-side and Transition Subregion				Total Acres: 9,862,000
Productivity Class	120+	85-119	50-84	20-49
Thousand Acres	655	2,148	5,399	1,660
Percent	7	22	55	16



Total Region				Total Acres: 16,520,000
Productivity Class	120+	85-119	50-84	20-49
Thousand Acres	3,480	3,700	7,390	1,950
Percent	21	22	45	12



Source: Regional Guide for the Pacific Northwest Region, 1984, USDA Forest Service.

The standing inventory of softwood sawtimber on commercial lands (capable of growing at least 20 cubic feet per acre per year) on Pacific Northwest Region Forests is of major significance when viewed from the National perspective.

Inventory

Table III-4

Standing Softwood Volumes—Based on International 1/4-Inch Scale—on Commercial Forest Lands of the Pacific Northwest Region

	Million Bd. Feet	Percent
Coastal and Western Cascades subregion	270,508	70
East-side and Transition subregion	<u>115,944</u>	<u>30</u>
Total	386,352	100

Source: *Regional Guide for the Pacific Northwest Region, 1984, USDA Forest Service.*

Demand for timber will vary with market and economic conditions, and is affected by short term decisions of other industrial and agency forest ownerships. As a general situation, however, there are purchasers for all volumes made available for harvest. Sale of timber from Forests will fluctuate somewhat on an annual basis according to National administrative and budget priorities. The 5-year average between 1975 to 1979 was 4.9 billion board feet sold on National Forests in Washington and Oregon.

Demand

Recent trends of both harvest levels and acres available for regulated harvest (the systematic removal of products) are reflected in the proposed Forest Plans. While conditions vary from Forest to Forest, the trends are for somewhat reduced programmed harvest levels in comparison with recent historic levels. For example, it is estimated that annual timber harvest (Allowable Sale Quantity) will be in the range of 3.8 to 4.3 billion board feet following implementation of the 19 Forest land management plans currently in preparation.

Recent Trends

Recent additions to the Wilderness System, allocations to protect sensitive resources, and analysis of costs have reduced the amount of timberland in the "base"; programmed harvest levels reflect this. Harvest of timber from all Forests, however, will continue to be a valuable and significant activity.

In many situations, the removal of forest trees is the mechanism for achieving habitat, visual quality, forest protection, and other

management objectives. In these cases, timber yields are the by-product of projects to enhance other resource values. They result from manipulation of forest density, species composition, horizontal or vertical distribution, and lesser vegetation.

Range Ecosystems

Current Situation

The Pacific Northwest Region contains 7,860,000 acres of range allotments. Of these, 6,300,000 acres are in Oregon and 1,560,000 acres are in Washington. More than 80 percent of National Forest grazing lands are forested, yet offer substantial opportunity for browse and forage.

The Pacific Northwest Region contains nearly 8 million acres of rangeland allotments.



The majority of the rangelands are in satisfactory condition in terms of site stability and vegetative composition. Range management opportunities exist throughout the Pacific Northwest Region. Eleven National Forests (partially or entirely east of the Cascade Mountains) produce a majority of the animal unit months of grazing by domestic livestock (see Appendix F). These are the Forests most likely to practice vegetation management to improve range characteristics. On other Forests, livestock grazing occurs primarily on transitory range resulting from timber harvest.

The National Forests in the Pacific Northwest produce an estimated 1.5 billion pounds of useable forage on established allotments. In fiscal year 1986, 144,500 cattle and 54,900 sheep used approximately 727,100 animal unit months of forage on 785 National Forest range allotments.

The greatest range opportunities are generally associated with those National Forests found either in part or totally within the Transition and East-side subregion (see Appendix F).

The vegetation types that perennially provide a constant base of forage include:

- 1) forested lands with a dominant bunchgrass understory;
- 2) pure grasslands;
- 3) shrub/bunchgrass;
- 4) juniper/shrub/bunchgrass; and
- 5) meadowlands.

Another very important type is transitory rangeland associated with managed forested lands. A more detailed description of each of these major types is available in Appendix F.

Riparian Vegetation

Riparian vegetation includes any nonaquatic vegetation that directly influences the stream environment. The riparian zone is the area bordering streams, lakes, and wetlands. It is transitional between aquatic and upland zones.

Riparian plant communities may be dominated by: 1) herbaceous species (mainly rushes, sedges, and grasses); 2) hardwood species (mostly alder, bigleaf maple, willows, Oregon ash, or black cottonwood); or 3) coniferous species (mostly western hemlock, Sitka spruce, or western redcedar).

There are approximately 775,000 acres of riparian areas within National Forest lands in the Pacific Northwest Region. Riparian areas constitute 1 to 6 percent of the suitable timberlands on East-side Forests, and 3 to 14 percent of the timberlands on West-side Forests.

While riparian areas occupy only a small part of the overall land base in the Region, they are a critical source of diversity (See Diversity, this chapter) within the forest ecosystem. They create distinct habitat zones within the drier surrounding areas.

Riparian vegetation provides a source of food, cover, shade, and woody debris for fish and wildlife. Vegetation growing along stream banks helps to stabilize the banks and create habitat for fish. The litter layer serves to filter sediment transported from upland areas by surface erosion. Riparian areas are also highly productive sites for timber and forage.

CFR 219.7 directs the Forest Service to protect riparian areas. No management activities are permitted within riparian areas that will

Major Rangeland Types

Current Conditions

Importance

cause detrimental changes in water quality, block water courses, or deposit sediment which will seriously and adversely affect water or fish. The Forest Service Manual (FSM 2526) provides further direction for protection of riparian areas.

Noxious Weeds

Background



The production of toxic chemicals, high rates of seed production, efficient seed dispersal, and rapid root growth and vegetative spread often give invading noxious weeds an advantage over desirable plant species. Canada thistle, illustrated here, is present in every county in Oregon and Washington.

While some plant species classified as noxious weeds (plants that have an adverse effect on humans or their environment) are native to the Northwest, most are introduced species from Europe or Asia. Weeds continue to be introduced and spread by contaminated seed, vehicles, livestock, and natural elements such as wind, water, and wildlife.

Noxious weeds include both herbaceous and brushy species that are able to adapt rapidly to a variety of environmental conditions. The rapid spread of these species is largely due to the fact that they were introduced without the natural complex of predators, competitors, and diseases that provided a natural means of control in their native habitats.

Characteristics such as production of toxic chemicals (allelopathy), high rates of seed production, efficient seed dispersal, and strong abilities for rapid root growth and vegetative spread often give invading noxious weeds an advantage over native plant species.

Noxious weeds often act as pioneer species. They are adapted to colonizing the exposed mineral soil of the disturbed sites. Many activities including timber harvest, grazing, prescribed burning, and road construction provide ideal sites for establishment and spread of these species.

As noxious weeds invade and occupy a site, they do so at the expense of native or desirable non-native plants. In most cases, native plant species will provide higher quality forage. In some cases, the displaced native plants may be threatened, endangered, or sensitive species.

Forests can serve as seed sources, providing corridors for noxious weeds to move into surrounding agricultural lands. Severe economic losses to farmers and ranchers have been attributed to noxious weed establishment and spread.

Current Conditions

The current distribution of noxious weeds in the Pacific Northwest Region varies by species. It depends (in part) on when the weeds were introduced, and how much suitable habitat is available for the establishment and spread of a given species.

For instance, Canada thistle is present in every county in Oregon and throughout most of Washington, while Dyers woad,

which is spreading into Oregon from the south, still has a relatively limited distribution. While tansy ragwort is common west of the Cascade Mountains (and is being spread eastward by interstate movement of livestock and hay), knapweeds are more common in eastern Oregon and Washington.

A complete list of noxious weeds by treatment class, including specific information about their distribution and spread by county, is available in the Final Environmental Impact Statement for the Northwest Area Noxious Weed Control Program published by the U.S. Department of the Interior, BLM, in 1985 (Appendices C-1, C-2, C-3, and Appendix D). Additional specific information is available in individual Forest noxious weed management plans.

A discussion of the basis for and the methods of noxious weed control can be found in Appendix G in the section on noxious weed control activities. Project-level analysis must be used to determine the method that is most effective and cost efficient for controlling weeds while minimizing the risks of adverse consequences.

The Oregon Department of Agriculture (ODA) has responsibility for noxious weed control within the State of Oregon. Control activities planned on National Forest lands are coordinated with and often completed in cooperation with the ODA.

Noxious weed control responsibilities lie with individual county weed control boards within Washington State. Cooperation with these weed control boards is essential for a successful program.

Cooperation With Other Agencies

Diversity

Diversity has both spatial and temporal dimensions. Differences in productive potential from site to site are spatial; differences related to time, successional changes, for example, are temporal. Site-specific prescriptions or projects plans should consider the need for both types of diversity.

Temporal diversity usually relates to change over time in species composition and structure following a disturbance.

Disturbances usually result from natural environmental extremes such as high wind, drought, flood, mass failure, or fire. Each of these agents has its own natural frequency—for example, 100-year floods, or the somewhat regular, almost predictable, occurrence of fire in Northwest ecosystems. Effects depend on the intensity and extent of the individual event. Severe fire, for example, can set back the ecosystem to early developmental stages, while less intense fires may only

Temporal Diversity

kill a few susceptible individuals.

Disturbances seemingly occur on a random basis. While this makes the natural ecosystem appear chaotic, the resulting variety of age classes (temporal diversity) support both early seral (an unstable early stage of development) and climax (the last stage of stand development) vegetation species. This contributes to the overall plant diversity essential to many species of wildlife.

Most areas in the Region have some variety in age classes (temporal diversity). The proportion of old-growth to young or recently disturbed stands depends partly on the periodicity of natural events.

Spatial Diversity

Spatial diversity is related to differences in site potential. It reflects the influence of the climate, and also the energy already stored at the site (in the soil, and in both living and dead vegetation).

The structural components, layers of vegetation, structure of the soil, and accumulated debris on the forest floor give each site a character that attracts animals and allows plants to find a niche to compete for resources. For a related overview, refer to the section in this chapter on Regional vegetation.

Current Conditions

We do not have a standard method of inventorying or computing a diversity index in the Region. Most Forests assess diversity by examining the array of existing age classes, and set standards for the proportions of land in each class and their spatial distribution.

There are many diversity indices, but their use for background levels and monitoring operational activities is questionable. Any discussion of the present conditions without a reference of standard would be of little use.

We can use vegetation management to help maintain diversity or reduce it, depending on the strategy used in application. Vegetation management activities are designed to take both structural diversity and species diversity over time and space into account. These activities can be patterned after the frequency, intensity, and extent of natural disturbances to maintain and possibly enhance the character of the ecosystem.

Threatened, Endangered, and Sensitive Plant Species

On National Forest lands in Oregon and Washington, only one plant species currently listed under the Endangered Species Act is known to occur. This is MacFarlane's four-o'clock (*Mirabilis macfarlanei*, listed as endangered), which grows at only a few locations in the Snake River country of Oregon and Idaho.

More than four hundred plant species are currently included on the Regional Forester's list of sensitive species, or are considered as potential additions to that list. These species are considered to be endangered, threatened, or sensitive by the States of Oregon and Washington; or are under review by the U.S. Fish and Wildlife Service.

These species include the full range of vascular plants, from grape-ferns and club mosses to orchids and grasses. They occupy a wide variety of habitats, though they tend to most often occur in less common areas such as wetlands or riparian areas; on rock outcrops; or in soils derived from unusual parent material, such as serpentine. Sensitive plant species can be found throughout the Region, but there are particularly high concentrations in areas such as the Siskiyou, Wenatchee, and Wallowa Mountains, and the Columbia River Gorge.

All Forest Service projects that might disturb these species or their habitat must be preceded by a biological evaluation (Forest Service Manual 2670). This process should determine whether these species or their habitats are present in the project area, and if so, whether there are potential adverse effects on the sensitive species. Mitigation measures or project modification may then be planned as appropriate.

When a listed species may be affected by planned Forest Service activities, consultation is initiated with the U.S. Fish and Wildlife Service to assure that activities will not jeopardize the continued survival of the species.

Current Conditions

Interactions

Cooperation With Other Agencies

Wildlife and Wildlife Habitat

Current Condition

Forests of the Pacific Northwest Region are known to provide habitat for 569 species of resident and migratory, terrestrial vertebrate wildlife (174 mammals, 335 birds, and 60 reptiles and amphibians). Lists of species and habitat relationships can be found in Thomas (1979), Thomas and Maser (1983), and Brown (1985).

Public demand for wildlife resources is measured by consumptive and nonconsumptive uses. Wildlife and fish user days (WFUD's) are used to report the demand for these resources. The most recent summary of these values (Annual Fish and Wildlife Report, 1984) shows that 8.3 million WFUD's were attributed to the wildlife resource. Appendix G provides a detailed listing by Forest.

Interactions

In order to maintain viable, self-sustaining populations of wildlife, an appropriate amount and distribution of suitable habitat must exist. The amount and distribution of habitat will vary over time. Changes in habitat condition and suitability can occur abruptly (as the result of fire, windstorm, or timber harvest), or more gradually (as in the slow replacement of plant communities characteristic of succession).

On forested sites, six different successional stages (or stand conditions) are usually recognized: grass-forb; shrub; open sapling-pole; closed sapling-pole; sawtimber; large sawtimber; and old growth (Brown, 1985). Each successional stage, in each forest community, supports a characteristic grouping of wildlife species.

While contrasts among successional stages are less dramatic in the grass-shrub steppe ecosystems, similar relationships between wildlife and vegetation characteristics apply. Some plant communities, such as wet meadows, may show little evidence of change over time.

Some species find suitable habitat in a wide variety of plant communities and stand conditions, while other species are more closely associated with one or a few plant communities and stand conditions. Species with specific habitat requirements are more apt to be susceptible to changes in vegetation.

Deer and elk use many plant communities—Shrub through old-growth successional stages—for hiding and/or thermal cover. Depending on environmental conditions and forage availability, they feed in a wide variety of plant communities and stand conditions. These species are relatively tolerant of changes in habitat conditions.

The western red-backed vole and northern spotted owl are dependent on older, closed-canopy forest stands. These species are sensitive to changes in stand conditions, and their population levels



Forests of the Pacific Northwest Region provide habitat for 569 species of vertebrate wildlife. To support self-sustaining wildlife populations, an appropriate amount and distribution of suitable habitat must be maintained.

could drop dramatically as stands are converted to younger age classes.

In grass- and shrub-dominated areas east of the Cascades, sage grouse breed only in areas with sagebrush, while green-tailed towhees utilize several communities containing various tall shrubs or trees.

In the absence of human manipulation, natural landscapes support characteristic patterns of plant communities and stand conditions. These reflect, in part, the frequency of disturbances, site productivity, and successional changes that occur over time. These relationships are discussed in the Diversity section of this chapter.

Most forested sites historically experienced stand-replacing fires at intervals of several hundred years. The long intervals between such events, combined with the longevity of trees such as Douglas-fir and the fire resistance of such trees as oak and ponderosa pine, led to a landscape comprised largely of mature and old-growth stands (Harris 1984).

As a result of clearing, logging, and wildfire, much forest land in Oregon and Washington is currently occupied by younger stand conditions. Some wildlife populations will increase as forested lands return to early successional stages, and those that thrive in older forests will decline.

In the grass- and shrub-dominated plant communities characteristic of the Columbia Plateau, climate, soils, and fires occurring at relatively frequent intervals tended to favor grasses over shrubs.

In the Great Basin, big sagebrush communities predominate. Fire suppression and grazing favor dominance of shrubs and juniper, with a corresponding shift in wildlife populations. These trends have been somewhat counterbalanced by management practices (such as brush control projects) that are intended to maintain grass/forb-dominated plant communities.

Wildlife distribution and abundance are influenced by vegetation, but animals also affect distribution and abundance of vegetation. Animals can carry and distribute seeds, and thus determine where plants grow. Grazing and browsing by wildlife can affect plant growth and vigor, including that of young trees.

Many wildlife species including bear, deer, elk, mountain beaver, porcupine, hares, rabbits, and various small rodents can have adverse effects on the survival and growth of conifers. Conversely, wildlife may browse vegetation that competes with conifer seedlings, and foraging by many bird species may provide natural control of insects which damage many conifer stands. Animals also play a vital role in dispersing spores of fungi essential to tree growth (Maser et al. 1978).

Interactions

Cooperation With Other Agencies

Management of wildlife populations involves a partnership between state and federal agencies. The Pacific Northwest Region has developed Memorandums of Understanding with the Oregon Department of Fish and Wildlife and the Washington Department of Game to facilitate the development of common goals and management strategies for the wildlife resource. These agreements provide opportunities for cooperative interagency planning, funding, and implementation of projects designed to benefit wildlife populations.

Threatened, Endangered, and Sensitive Animal Species

Current Condition

Six wildlife species currently listed by the U.S. Fish and Wildlife Service as endangered or threatened under the Endangered Species Act are known or suspected to occur on National Forest lands in the Pacific Northwest. These species and their status are listed in Table III-5.

Table III-5

Threatened and Endangered Wildlife Species

Gray wolf	<i>Canis lupus</i>	E
Grizzly bear	<i>Ursus arctos</i>	T
Woodland caribou	<i>Rangifer tarandus californiana</i>	E
Brown pelican	<i>Pelecanus occidentalis</i>	E
Northern bald eagle	<i>Haliaeetus leucocephalus</i>	T
American peregrine falcon	<i>Falco peregrinus anatum</i>	E

T = Threatened E = Endangered



Six wildlife species in the Pacific Northwest Region are currently listed as threatened or endangered. Among them is the northern bald eagle, pictured here.

These species differ widely in their distribution in the Northwest. The brown pelican is known only from coastal portions of the Siuslaw National Forest. Woodland caribou occur only on the Colville National Forest. In the state of Washington, grizzly bear and gray wolf have documented or suspected occurrences in four and five Forests, respectively. Peregrine falcons are known or suspected to occur on all but three National Forests in the Region, and the bald eagle is known to have nesting, winter roosting, or migratory sites on all 19 Forests.

Thirty-six other species (8 mammals, 14 birds, 1 reptile, 3 amphibians, and 10 fish) are included on the Regional list of Sensitive Species. This list includes species considered by the states of Oregon or Washington to be threatened or endangered, and species under review by the U.S. Fish and Wildlife Service.

All Forest Service activities that might disturb these species or their habitat must be preceded by a biological evaluation (Forest Service Manual 2670). This process should determine whether these species or their habitats are present in the project area, and if so, whether there are potential adverse effects on the sensitive species. Mitigation measures or project modification may then be planned as appropriate.

Whenever proposed Forest Service projects may affect any of these species, consultation is initiated with the U.S. Fish and Wildlife Service to assure that activities will not jeopardize continued survival of the species. The Forest Service also cooperates with other federal agencies and state wildlife agencies in efforts to improve habitat for these species. Cooperative efforts to reintroduce some of these species into portions of their former ranges are also underway.

Fisheries

The Pacific Northwest Region has approximately 15,000 miles of streams that directly support both resident and anadromous fish. There are approximately 150,000 acres of lakes and 65,000 acres of reservoirs that can support both warm- and cold-water species of fish. These aquatic habitats range from estuaries on the Siuslaw National Forest to alpine lakes along the Cascade Crest.



Resident game fish include rainbow, eastern brook, Dolly Varden, and cutthroat trout; crappie; bluegill; yellow perch; smallmouth and largemouth bass; Kokanee; and mountain whitefish. All are highly valued as recreational fish.

Interactions

Cooperation With Other Agencies

Current Conditions

Streams on 15 of the 19 Pacific Northwest Region Forests provide spawning and rearing habitat for anadromous fish species such as salmon, steelhead, and sea-run cutthroat trout.

Anadromous fish (fish that spawn in fresh water and migrate to the ocean to mature) have both sport and commercial value. They are found on 15 of the 19 Forests in the Region. Pink, chum, coho, sockeye, and chinook salmon; steelhead; and sea-run cutthroat trout depend on streams in the Region for spawning and rearing habitat.

Interactions

Vegetation management activities have the potential to affect fish habitat characteristics such as water temperature; sediment load; turbidity; water quantity, and timing of flow; and the character of streamside vegetation. The quality of fish habitat is dependent upon management practices in the watershed which affect the quantity of water and sediment in the stream. Particularly important are management practices within the riparian zone (the interface between terrestrial and aquatic ecosystems).

Cooperation With Other Agencies

The Pacific Northwest Region has agreements with the Washington Department of Fisheries; the Washington Department of Game; the Oregon Department of Fish and Wildlife; and the State of California Department of Fish and Game concerning protection and maintenance of viable habitat for fish and wildlife.

Insects and Disease

Forest disease or insect populations can have a direct effect on the vigor and response of managed vegetation. The complex of pest-host interrelationships may often define the opportunities or limitations for regulation of the forest environment. This component of the environment can sometimes require suppression or control in order to achieve land management objectives.

Pests include insects, microorganisms, nematodes, atmospheric pollutants, or non-infectious disease-causing agents considered detrimental to achievement of management goals. Most forest vegetation is damaged by an insect-pathogen complex. Frequently, the stand or site conditions are predisposing factors in population buildup. The objective in pest management is to manage populations or limit damage to tolerable levels. Damage may represent an economic loss such as tree mortality, deformity, or growth loss. In other cases, it may affect resource values such as scenic quality and fuel levels contributing to fire hazard.

The extent and nature of pest populations often requires cooperative management strategies between different private, local, state, and Federal land ownerships. Insect and disease control efforts in the Pacific Northwest Region are achieved through a decisionmak-



Suppression or control of damaging or disease-carrying insect populations is sometimes necessary to alleviate potential economic, scenic, or recreational losses on National Forests. Shown here, patterns of galleries made by Douglas-fir beetles.

ing and action process within a policy that incorporates biological, economic, and environmental evaluations of pest-host systems to manage pest populations.

Pest management activities may involve prevention, detection, evaluation, suppression, and monitoring. The common need in forest management is to be able to accurately evaluate the seriousness of routine insect or disease problems. Management strategies must then be integrated into silvicultural and other management practices in order to limit the impact of insects and diseases.

Several forest insects are currently of management significance in the Pacific Northwest Region: the western spruce budworm; the gypsy moth; grasshoppers; and both the mountain and western pine bark beetles.

Several forest diseases are currently of management concern, including a number of root diseases (annosus, armillaria, blackstain, laminated root rot, and Port-Orford cedar root disease); various stem decays; dwarf-mistletoe; and white pine blister rust.

Land Uses

Land ownership patterns within the Pacific Northwest Region of the Forest Service are highly complex around and within National Forest boundaries. Many of the private holdings are managed for timber production by private industrial owners. State and Federal agencies (the Oregon Department of Forestry; Washington Department of Natural Resources; and the USDI Bureau of Land Management, for example) also manage large tracts of land within and adjacent to the boundaries of the Region.

The Region is comprised of 24,545,814 acres of National Forest system land (1986 figures). This land is contained within 23,894 miles of boundary. Also contained within this boundary are 2,765,197 acres of lands in other ownerships.

Smaller landowners use their land for a variety of purposes—recreational residences, organizational uses, farms, small woodlots, and small businesses, to name a few.

Generally, large, private, industrial landowners tend to emphasize uses of the environment different than those of smaller landowners. For example, large, private timber holdings are usually intensively managed for timber production; less emphasis may be put on other resources. Small landowners, on the other hand, are usually more concerned with things such as scenic and environmental qualities, herbicide spray “drift,” and noxious weed control.

Recreation

National Forests of the Pacific Northwest have highly diversified natural landscapes, ranging from seacoast to alpine meadows to desert. These offer a correspondingly wide range of recreation opportunities, from clamming to skiing; resorts to wilderness. The Forests, open year-round, receive considerable recreation use, with activities varying according to the season.

There are two Forest Service classifications for recreation: dispersed, and developed.

Dispersed recreation consists of activities that involve little interaction between users. Examples of this include hiking, hunting, and camping in undeveloped or remote locations.

Developed recreation is a concentrated form of recreation involving a range of facilities, from campgrounds to all-season resorts. Examples include family and group campgrounds and picnic areas, winter sports sites, and swimming and boating sites.

Vegetation management is used in forest recreation areas to provide for public safety by reducing fire hazards and controlling poisonous plants and noxious weeds; to improve visibility and access; and to create and maintain a natural-looking environment.

The Regional objective is to increase the supply of outdoor recreation opportunities and services through programs that emphasize dispersed recreation. Current use levels of developed or concentrated site recreation will be maintained.

Use of the Pacific Northwest Region’s (slightly over 1,900) developed recreation sites currently equals over 13 million Recreation Visitor Days (RVD’s). A Recreation Visitor Day is defined as being

equal to 12 hours spent by a visitor. This figure includes RVD's at Forest Service operations; permittee operations; and privately-owned sites within National Forest boundaries.

Historically, the Forest Service has expended approximately two percent of its annual recreation operation and maintenance budget to control vegetation in developed recreation sites. For Fiscal Year 1985, this amounted to slightly over \$200,000. This trend is expected to continue.

Dispersed recreation accounts for over 18 million Recreation Visitor Days on approximately 1,700 dispersed recreation areas. Because of the nature of dispersed recreation, very little vegetation management takes place in these areas. While dispersed recreation will likely increase in the future, there will be an almost-negligible increase in vegetation management.

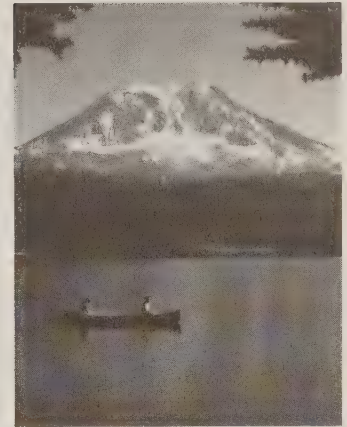
Vegetation management techniques presently (and historically) used in recreation sites consist almost exclusively of manual and mechanical means. Herbicides (when allowed, prior to the injunction) have been a preferred treatment for poison oak and other toxic plants, as both cutting and burning expose employees to toxic effects and generally afford only temporary results.

Facilities

Forest Service facilities range from buildings and compounds constructed around the turn of the century, to modern, state-of-the-art research labs and offices. Vegetation management provides protection to buildings and property, safe working conditions, and an aesthetically pleasing appearance for the facility.

Historically, less than one percent of the total facilities maintenance budget has gone to vegetation control. Work consists primarily of grounds maintenance: lawn and shrub care, and control of blackberry, morning glory, poison oak, and other weeds. Moss buildup on roofs and sidewalks is also a problem that must be dealt with in the Pacific Northwest Region.

Current efforts to control vegetation have generally been considered adequate, and it is estimated that this level of maintenance will continue in the future. Loss of herbicide use to control weeds and moss has not had a major effect on facilities maintenance. Some of the work has been done by manual methods (cutting weeds by hand, for example), and other areas have been temporarily ignored (some poison oak control, and moss buildups). These problems will eventually have to be corrected, but are not considered major problems.



Diverse natural landscapes in the National Forests offer hundreds of recreational opportunities.

Rights-Of-Way Maintenance

Forest Service Roads



The Forest Service currently maintains nearly 88,000 miles of roads in the Pacific Northwest Region. Roadside vegetation has been controlled using chemical, mechanical, manual, and biological methods.

Forest roads are of primary importance for the protection, administration, and utilization of the National Forests and other areas administered by the Forest Service.

The Forest Service currently maintains almost 88,000 miles of roads in the Pacific Northwest Region. Approximately 15-20 percent of the annual road maintenance budget is spent on managing competing and unwanted vegetation. At present, the Region has over 30 percent of its open-to-the-public roads in a "not maintained to standard" category. Much of the maintenance that is not to standard is in the area of roadside vegetation, especially on those Forests west of the Cascades.

The Regional budget for road maintenance has decreased more than 36 percent over the past five years. This has resulted in fewer dollars available for vegetation management, and a corresponding increase in the backlog of work to be done. Several West-side Oregon and Washington Forests have had to allocate a larger percentage of their maintenance dollars to vegetation management, and are still falling behind on their brush control work since the injunction against herbicide use has been in effect.

The Region currently constructs approximately 600 miles of road each year, which generates about 3,000 acres of vegetative debris requiring disposal. The majority of the debris is scattered along the roadside and left for firewood or to decompose. About 700 to 800 acres per year is piled and burned during the construction operations. Other options used for clearing debris are windrowing, burying, chipping, removal, piling, and placing on embankment slopes.

Highways

Roads and highways within the National Forests of Oregon and Washington that are managed by other agencies (county, state, and Federal) are of primary importance for access and transportation of goods and services. These agencies maintain approximately 4,300 miles of roads and highways (over 34,000 acres) within the National Forests of Oregon and Washington.

Historically, roadside vegetation along these roads has been controlled using chemical, mechanical, manual, and biological methods. Vegetation management is performed on road shoulders to enhance drainage of surface and subsurface water; on cut slopes and fill slopes to provide increased sight distances; to prevent icy spots from forming due to roadway shading; and to provide for rights-of-way vegetation control of danger trees along roadsides.

Many public and private utilities have rights-of-way through the Region's National Forests. Power line and communication utilities have above-ground and buried cable line rights-of-way and access roads; towers; and substations and relay stations.

Vegetation management is performed on the above to enhance the reliability of the transmission system, and to provide safety for those working around the facilities.

In some areas, the repeated control of tall-growing vegetation tends to encourage low-growing species to flourish and spread, while in other areas, tall-growing species will perpetually return, necessitating periodic control.

In forested areas, cleared rights-of-way may function as limited fire breaks and provide access for the control of wildfires. In developed areas, transmission line rights-of-way may function as desirable open space, recreational areas, or storage areas.

The main goal of vegetation management for railroads is to prevent train-caused fires along the right-of-way. Other objectives include maintaining the roadbed; eliminating safety and nuisance problems for railroad personnel; maintaining ditches and other drainage structures; and providing increased site distance at railroad crossings.

Railroads have rights-of-way, access roads, crossings, and communication lines throughout Oregon and Washington that require annual vegetation control. This involves approximately 105 miles (over 2,400 acres) within National Forest lands in the Pacific Northwest Region.

Trails provide outdoor recreation opportunities for the Nation, as well as access to scenic and cultural resources within the National Forest System. Vegetation along these trails is controlled to provide for user safety, as well as to protect the investment.

Vegetation is generally cleared two to four feet on each side of the trail tread to varying heights, depending on the intended use of the trail.

Most vegetation clearing is done manually, with some mechanical work also performed. Chemical treatments are rarely used.

In order to delineate property lines and administrative boundaries, the Forest Service has implemented a land surveying program that identifies, marks, posts, and maintains legal property lines.

While identified property corners are marked and then maintained periodically to preserve them, few actual miles of property lines are maintained on a regular, prescribed basis. Approximately 150 miles of line will be maintained this year, which amounts to less than

Utility Corridors

Railroads

Trails

Land Line Location

100 acres. By 1990, the Region expects to have increased this to about 800 miles (approximately 400 acres) of land line maintenance per year. Manual methods of vegetation control are nearly always used.

Scenery

The Pacific Northwest Region contains scenic landscapes that vary from coastal rain forests and snow-covered mountain peaks to open rangelands.

A program has been developed for managing the scenic quality of the visual resources of the National Forests. Vegetation management provides an opportunity to maintain or enhance them.

The program includes a comprehensive evaluation of (1) scenic quality (variety); (2) level of sensitivity (people's concern for scenic quality); and (3) viewer positions relative to forest lands. A series of recommended visual quality objectives for each specific area are derived from these considerations.

Distinct visual character types are found in the Region. These are functions of landform, vegetation, water forms, rock formations, and natural processes. For management purposes, scenic quality within each character type is rated as:

- distinctive (unusual or outstanding visual quality);
- common (features exhibit variety in form, line, color, and texture, but are common in the character type); or
- minimal (little visual variety).

Factors affecting landscape appearance include canopy characteristics; diversity of vegetation species; natural openings (such as meadows or rock outcrops); soil color (including lightness or darkness); and slope.

Scenery—for planning, design, and management purposes—is divided into foreground, middleground, or background. These are all relative to the viewer's distance from a given landscape. By changing location, an area's classification and scenic importance may change. Thus, all roads, trails, use areas, and water bodies are evaluated for user sensitivity (high, medium, or low) based on the type and volume of use, the duration of use, and the recreation importance of the road or site.

Scenery is managed to meet objectives which describe differing degrees of acceptable alteration of the natural landscape. Specific discussions of each objective can be found in the National Forest Landscape Management, Vol. II, Chapter 1, USDA Handbook No. 462, on file at the Pacific Northwest Regional Office.

In some of the objectives, management activities are visually

subordinate to the natural landscape character, and the natural character is dominant. In others, management activities are allowed to dominate the natural landscape.

Some landscapes vary in their capability to absorb the impacts of similar management activities. Thus, the same actions may result in different effects on various landscape types. Vegetation management treatments may have to be modified to meet visual quality objectives, particularly in more sensitive landscapes with low or moderate capability for absorbing these impacts.

Cultural Resources

Cultural resources are artifacts, buildings, or sites resulting from human activity in a past era. They can be archaeological (generally associated with Native Americans), or historical (associated with early settlement and development). Examples of cultural resources are remnants of foot paths and wagon roads; abandoned trading posts; and abandoned homesteads.



Cultural resources—artifacts, buildings, or sites—are finite, irreplaceable resources. Federal laws and formal procedures assure their protection and preservation for future generations.

Cultural resources are finite resources and are unique in that they are irreplaceable. They can have historical, archaeological, architectural, scientific, informational, or cultural values of great interest and concern to the public. Faced with the possible loss of these important treasures, Congress has acted to protect them by passing such laws as the Preservation of American Antiquities Act of 1906; the National Historic Preservation Act of 1966, amended in 1980; the Arch-

eological Resource Protection Act of 1979; Executive Order 11539; and the American Indian Religious Freedom Act.

These laws and regulations require Federal agencies to manage the significant cultural resources under their control. To accomplish this, a combination of inventory, protection, and enhancement actions are used. The cultural resource laws and regulations provide specific procedures that must be followed to assure that cultural resource values are considered in any decisionmaking process. Compliance with these procedures requires the land manager to accomplish a series of tasks that includes inventorying, evaluating, determining effects, and mitigating adverse effects.

Prior to initiating any proposed vegetation project, a reconnaissance survey is required to obtain an inventory of cultural values. These might include any special local uses of the area by Native Americans for spiritual or cultural activities. Some keys for identifying cultural resource sites include such subtle things as differences in native vegetation; exotic vegetation; or excavations.

Public Health

As of 1984, approximately 7 million people resided in Oregon and Washington (combined). Washington's recorded population was 4.35 million people; Oregon's was 2.67 million. People in the region enjoy above-average good health, compared to the total U.S. population.

The overall 1982 death rate per 100,000 in Washington was 755.4; in Oregon 810.1; and in the U.S., 852.0. The figures for cancer deaths were 171.0; 179.4; and 187.2, respectively.

In contrast, the death rates from accidents were 41.4 in Washington; 41.6 in Oregon; and 40.6 nationally.

The Forest Service estimates that 100,000 people live within one mile of the National Forests (including 30,000 who live within a quarter-mile). The Forest Service reports a trend of increasing numbers of residents near National Forests.

This increasing proximity of people living near lands managed by the Forest Service has resulted in increasing public concern with environmental issues such as air and water quality and public health. In particular, health concerns have been raised about 1) use of pesticides and 2) smoke from fires.

Herbicide Use

Currently, no herbicides are being used in the Pacific Northwest

Region of the Forest Service. Until 1982, however, the Region used herbicides to control unwanted vegetation in its forests, rangelands, and along rights-of-way.

Sixteen herbicides have recently been used by the Region and are currently being considered for potential future use. In the past, four of these accounted for the bulk of use. The remaining 12 were used on less than 5 percent of the acres treated. The herbicides 2,4-D and Glyphosate each accounted for roughly one-third of the total acres sprayed (see Table III-6 and Appendix D).

Table III-6

Forest Service Herbicide Use Before 1982, Pacific Northwest

	<i>Herbicide</i>	<i>Percent of Treated Acreage</i>
Major use	2,4-D	Approx. 38%
	Glyphosate	Approx. 31%
	Picloram	Approx. 8%
	Triclopyr	Approx. 7%
Minor use: (In order of approximate usage)	Dalapon	Less than 5%
	Atrazine	Less than 5%
	2,4-DP	Less than 5%
	Hexazinone	Less than 5%
	Fosamine	Less than 5%
	Dicamba	Less than 5%
	Asulam	Less than 5%
	Tebuthiuron	Less than 5%
	Diuron	Less than 5%
	Simazine	Less than 5%
	Bromacil	Less than 5%
	Amitrole	Less than 5%

The Forest Service has historically sprayed about 40.6 thousand acres per year (less than two-tenths of one percent of the total land area). Two-thirds of this was for silviculture (site preparation and release), with another one-fifth used for rights-of-way maintenance.

Historically, approximately 600 workers were involved in approximately 12,000 person-days of herbicide spraying. More than 200 workers (approximately 3,000 person-days) were involved in spraying for silviculture purposes. Table III-7 shows average numbers of workers used for various programs.

Table III-7

**Average Numbers of Workers for Herbicide Application Activities,
By Type of Application**

Silviculture—Aerial (Helicopter)

Requires 20-25 workers (one pilot; one contractor's representative; ten flaggers; three inspectors; two or three traffic control law enforcement officers; three to five water monitors; one general support person; and one radio technician).

Total Yearly Workers: 200-250 (2,500-3,500 person-days).

Silviculture—Ground (Backpack Spray and Hand Application)

Requires 12-15 workers (one contractor's representative; one foreman; five or six crew members; one inspector; two to four general support workers; and two or three monitors).

Total Yearly Workers: 100-150 (3,800-4,300 person-days).

Range Improvement—Aerial (Fixed-wing Aircraft)

Requires five workers per project (one pilot; one contractor's representative; a Forest Service administrator; and two flaggers).

Total Yearly Workers: 25-30 (300-350 person days).

Noxious Weeds—Ground (Backpack Spray and Hand Application)

Requires one or two licensed applicators per project.

Total Yearly Workers: 140-150 (1,500-2,200 person-days).

Rights-of-Way—Ground (Truck or Backpack Spray)

Requires three workers (one driver; and one or two applicators).

Total Yearly Workers: 100-125 (3,000-3,500 person-days).

Facilities Maintenance—Ground (Backpack Spray and Hand Application)

Requires three workers (one supervisor and one or two applicators).

Total Yearly Workers: (approx. 50-60 person-days).

Social and Economic Conditions

The area of influence for the purposes of this report—the people and communities most directly influenced by National Forest vegetation management activities and outputs of the Pacific Northwest Region—comprises the states of Oregon and Washington. The social and economic conditions of these two states, and their principal ties to National Forests in the Region, are described below.

The Region, West and East

Oregon and Washington contain a great variety of land forms that reflect the results of water, volcanic, and glacial events. The major

geological feature is the Cascade Mountain Range, which parallels the Pacific coastline about 100 miles inland. This rugged range divides the Region into two distinct zones. Climate, vegetation, the economy, and population patterns are different on the west and east sides of the Cascades.

The western part of the Region has 5.7 million people. It contains the majority of the population of the two states. Eighty-seven percent of Oregon's population and 69 percent of Washington's population reside west of the Cascades. Population centers are concentrated along the Puget Sound in Washington, and the Willamette Valley in Oregon.

They are linked by north-south Interstate Highway 5, and by the Southern Pacific, Burlington Northern, and Union Pacific railroads. Major ports on Puget Sound and the Columbia River provide trade links to the Pacific Ocean nations.

The economy of the western portion of the Region is relatively diversified; more so in Washington than in Oregon, however. Aircraft manufacturing, shipbuilding, forest products industries, major financial centers, service and trade centers, educational centers, government, commercial fishing, agriculture, the livestock industry, recreation facilities, and mining all contribute to the economic picture.

The eastern part of the Region is two-thirds of the land area of Oregon and Washington. It contains a smaller proportion of the population: about 13 percent of Oregonians and 31 percent of Washingtonians live east of the Cascade Mountains. Oregon has no metropolitan areas on the East-side; Washington has the Yakima, Tri-Cities, and Spokane Standard Metropolitan Statistical Areas (SMSA's).

Major transportation linkages include Interstate Highway 90 and the Burlington Northern Railroad (providing east-west transportation), supplemented by the Columbia River corridor, with rail, Interstate Highway 84, and barge transportation. The remaining East-side area is not as well served.

The economy of the eastern portion of the Region depends more on agriculture, forest products industries, and the livestock industry than does the western portion. The relative dependence on these sectors has not been balanced by growth in other major employment sectors, except for some localized growth in recreation and service industries. The East-side has fewer opportunities for employment. The cities and towns reflect a rural-based economy with little diversification.

The Pacific Northwest is a Region in transition—transition which is necessarily moving the region to a more diversified economic base. The traditional employment sectors simply do not have the same

The West-side

The East-side

labor requirements as they did in the past. Many felt that the natural wonders of the area would be sufficient to guarantee its growth. Actually, growth has declined markedly, as shown in Table III-8.

Population

The population of Oregon and Washington was 6,763,312 in 1980, an increase of over 2 million people in two decades, equaling a 1.9 percent annual growth rate. Since 1980, the annual rate of growth has slowed to 0.8 percent, with the great bulk of it occurring in Washington.

Table III-8

Population Size and Growth Rates Oregon and Washington

	1960	1980	1986	Average Annual Rate of Increase (Percent)	
				1960-1980	1980-1986
Washington	2,853,214	4,130,163	4,419,700	1.9	1.1
Oregon	1,768,687	2,633,149	2,659,500	2.0	0.2
Total	4,621,901	6,763,312	7,079,200	1.9	0.8

Source of 1960 and 1980 Data: 1980 Census. 1986 Oregon data calculated from Table 3 of Population Estimates of Oregon, Counties and Cities, July 1, 1986, published by the Center for Population Research and Census, School of Urban and Public Affairs, Portland State University. 1986 Washington data calculated from Table 9 of 1986 Population Trends for Washington State, August, 1986, published by the Office of Financial Management of the State of Washington.

Urban/Rural Population

There are significant differences between Washington and Oregon in the distribution of population. Washington contains 61 percent of the Region's population; the vast majority of these residents live in urban areas. There are five metropolitan areas in Western Washington—Bellingham, Seattle-Everett, Bremerton, Tacoma, and Olympia. Three more are east of the Cascades—Yakima, Spokane, and Richland-Kennewick-Pasco.

Oregon's population, with 39 percent of the Region's total, is also primarily urban. The state has four metropolitan areas, all on the west side of the Cascades—Portland (which includes Vancouver, Washington), Salem, Eugene-Springfield, and Medford. Table III-9 shows the 1980 distribution of population between urban and rural areas.

Table III-9.

Population Distribution—Urban and Rural, 1980

	<i>Urban</i>	<i>Rural</i>
Washington	74%	26%
Oregon	68%	32%

Racial and cultural minorities are a small segment of the two states' population. In 1980, Blacks comprised 2 percent of the population; American Indians 1 percent; Hispanics 2 percent; and Asians 2 percent. Blacks in the Region are predominately urban in their residence, while Native Americans and Hispanics are more rural than the overall population.

There are over 20 Indian Reservations in the two states. Many are adjacent to National Forests, and Native Americans have significant concerns about Forest resources and management.

The age composition of the Region's population has shifted since 1970 in that a larger proportion of the population were of working age by 1980. A significant increase in the number of women in the labor force occurred for women aged 16 and over—from 43 percent to 52 percent. As the age structure of the Region continues to shift, the size and other characteristics of the labor force will be impacted (BPA, 1982).

The Pacific Northwest has a history of dependence on resource-based industries. Diversification, an ongoing process, is more advanced in Washington than in Oregon. The Pacific Northwest Region is noted for its environmental quality, is located favorably for foreign trade, and has a well-educated work force.

The major centers of growth and diversification are in the Puget Sound, Spokane, and Willamette Valley metropolitan areas. While employment in agriculture and lumber and wood products has declined over time, the natural resources of the Region will continue to play an important role in its economic base. Table III-10 summarizes recent area employment.

Minorities

Age, Sex, and Labor Force Participation

The Economy

Table III-10

Employment in Oregon and Washington in the Mid-1980's
(Thousands of Jobs)

	Oregon	Washington	Total
Total (100%)	1,210	1,617	2,827
Lumber & Wood Products	64 (5.3%)	41 (2.5%)	105 (3.7%)
Paper & Allied Products	9 (0.7%)	16 (0.9%)	25 (0.8%)
Agriculture, Forestry, and Fishing	23 (1.9%)	44 (2.7%)	67 (2.4%)

Oregon data for the above table are for 1985. They were taken from page 2 of Oregon Industrial Outlook, published by the Employment Division, Department of Human Resources, State of Oregon (RS PUB 78 (5-86)). Washington data for the above table are for 1984. They are taken from page 113 of Employment and Payrolls in Washington State by County and Industry, Fourth Quarter 1984, No. 153, January 1986.

Data from the two states are not necessarily comparable, due to differences in definitions. Data shown represent covered employment, and thus are exclusive of proprietors, family-member work on farms, and others.

Lifestyles, Attitudes, Beliefs, and Values

Many people find the Pacific Northwest to be an appealing place to live. To some extent, that finding has been translated into the location of new enterprises in the area. As much as anything else, though, the 1980's are likely to be remembered as the time when the Pacific Northwest realized that its continued growth would not come about without effort—that it would have to work to attract suitable employers, and that other locations in the nation were also viewed as being desirable places to live and work.

Certainly, there is no one Regional lifestyle or set of attitudes, beliefs, and values. Such generalizations are inaccurate today, just as they were in the past. Continuing improvements in technology have helped shift the metropolitan economies from their historical resource bases to more diversified bases. Strong environmental concerns have developed which are not restricted geographically or by occupation.

Because the economies of the rural communities are more typically associated with commodity production, residents of those areas are frequently perceived as being more likely to favor higher production levels and heightened development. Residents of metropolitan areas, whose livelihoods are not directly or noticeably linked to

the extraction of natural resources, are more commonly viewed as favoring environmental concerns. The relationship is not that cut-and-dried, of course, as is demonstrated, for example, by a 1986 public opinion survey conducted by the Oregon State Board of Forestry.

Vegetation management affects lifestyles, attitudes, beliefs, and values directly—as people see the Forest Service taking action or adopting a “no action” posture relative to vegetation management—and indirectly as decisions on vegetation management are ultimately reflected in changes in timber harvest levels and other Forest outputs and activities.

Environmentalists live in rural areas as well as in metropolitan areas, just as do those who favor development of the resource base. Too, there is no simple line of demarcation between these camps. Environmentalists are concerned about their neighbors’ jobs, and millworkers are frequently among the first to note their concern for the environment.

The economy of the Pacific Northwest is slowly but surely moving toward more diversity, away from its historic dependence on the extraction of natural resources, and the initial manufacturing of them. With that change comes a greater regional resilience to economic cycles, and an increasingly important role for National Forests as places of recreation, natural diversity, and high environmental quality. Within that context of change may be additional changes stemming from the alternative ways of managing vegetation management proposed in this EIS.

Chapter IV

Environmental Consequences

4

Chapter IV

Environmental Consequences

This chapter presents the environmental consequences that would occur if the alternatives and vegetation management methods presented in this EIS should be implemented.

It provides the information that is the basis for the comparison of alternatives presented in the last part of Chapter II.

The chapter opens with two general background discussions—one on how the effects were estimated, and one on how uncertainty was addressed in that analysis. The remainder describes the environmental consequences of the alternatives. The chapter closes with summaries of the most important significant effects.

How the Chapter Is Organized

Background

Environmental consequences (or effects, or impacts—we use the terms interchangeably) occur when ecosystems are changed—whether through management action or inaction. Under each alternative, we would manage problem vegetation in a different way. In this chapter, we present the environmental consequences of those different management alternatives.

The core of the chapter is organized by environmental components, such as “soils,” “wildlife,” and “social and economic effects.” Each section starts with the management changes that would affect it. Next, direct environmental effects are discussed, along with the reasons they occur. Changes in one part of the environment often lead to changes in other parts. These indirect effects are presented also.

Small changes happening repeatedly in the same place—or in a lot of places—may have a large effect. These “cumulative impacts” are discussed where they are foreseen. Where impacts would conflict with the plans and policies of other agencies, they are presented.

All the alternatives specify ways to avoid, reduce, minimize, and rectify potential adverse impacts. These are called “mitigation measures”. In estimating environmental effects, these measures are assumed to be in place and effective. Where appropriate, the different

Estimating Environmental Consequences

Site-Specific Environmental Effects

sections will indicate known experience with these mitigation measures, their dependability, and the consequences should they fail.

The vegetation management program involves hundreds of site-specific projects across the Region over several years. The environmental consequences of each one of them will be different, depending on the characteristics of the land, vegetation, and animals on that site; the weather and the time of year; and on how the activity is conducted.

In this environmental impact statement, the environmental effects are generally presented as Regional effects, with special attention given to effects that vary predictably by subregion.

In order to properly analyze and disclose the environmental consequences of these projects, an environmental analysis will be conducted. This analysis (along with informing the public) is a required part of Forest Service resource management projects (Forest Service Manual 1950).

For each project and site, the environmental consequences will be estimated in an environmental analysis. When the impacts analyzed are found to not significantly affect the human environment, they are documented in an "*environmental assessment*."

When the activity is routine and the impacts (based on past experience and environmental analysis) will have no significant impact on the human environment, the environmental analysis may be "*categorically excluded*" from being documented (Forest Service Manual 1952.2).

When the site-specific environmental analysis finds that the action would significantly affect the quality of the human environment, an environmental impact statement is prepared.

Regional Environmental Effects

The Pacific Northwest Region has a large number and variety of vegetation needs, in a large variety of plant communities and ecological settings. The problem faced by the interdisciplinary team was how to estimate the environmental effects of a complex Region-wide program in such a complex environment.

Resource managers and specialists on the individual National Forests are in the best position to know the extent and nature of vegetation management needs on their Forests. The team decided to draw on this knowledge, using the expertise from all 19 National Forests to help identify the extent, nature, and costs of vegetation management associated with each alternative.

This information about each alternative, combined with the interdisciplinary team's knowledge of ecological processes, research

literature, and forest management experience, was the basis for estimating the Regional environmental impacts of the alternatives.



The expertise of resource managers and specialists from all 19 National Forests of the Pacific Northwest Region was used to help identify the extent, nature, and costs of vegetation management associated with each alternative presented in this EIS.

This analysis of environmental effects and resource management was greatly aided by frequent contact with Forest Service resource specialists and scientists, and by their participation in the reviews of rough drafts of the environmental impact statement.

Much of the material on human health effects was compiled, analyzed, and reviewed by members of the University of Washington's Department of Environmental Health.

Silvicultural analysis and other parts of the document were reviewed by faculty at the College of Forestry, Oregon State University. (While their endorsement is not implied, their comments were helpful to the interdisciplinary team.)

The environmental consequences of different alternatives can best be analyzed, described, and compared by noting their differences from a common future—a “reference” line or point.

To estimate the effects of the alternatives on Regional programs and the environment, a reference was needed. This reference would describe probable levels of activities, production, and environmental conditions. The levels and specifications of the Region's proposed Forest Plans—as presented in both published proposed Plans and pre-publication drafts—were used as that reference.

The alternatives in this EIS look forward. None seek to replicate management conditions of the past. All are equally applicable to implementing current or future Forest Plans.

Alternative B specifically uses the same assumptions and levels as the proposed Forest Plans. It is the reference in this EIS.

The “Reference”

When information was requested from the National Forests on the management and environmental effects of the vegetation management alternatives, it was in terms of changes from Alternative B. Alternative B was the sum of all 19 Forests' best estimates of activities that would occur once their respective Forest Plans were implemented.

We recognize the strong likelihood that our reference will change as Forest Plans are developed. Public comments on the proposed Forest Plans, changes to improve the analysis, and changes in Regional Guide direction will cause these Forest Plan levels to vary. The Forest Plans may be affected by this vegetation management EIS, for instance.

However, as Forest Plan activities and outputs vary, they cause similar effects on all the vegetation management alternatives. In much the same way that a rising tide lifts all boats, changes from the currently estimated production levels and environmental conditions would be reflected in similar changes in the levels estimated for our alternatives.

The important dimension is the direction and extent that vegetation management alternatives vary from a common, reasonable condition. If that common condition does not precisely predict the future, it does not detract from the analysis and comparison of the alternatives in this EIS.

Types of Effects Estimated

The National Environmental Policy Act (NEPA), while incorporating social and economic effects, places a clear emphasis on impacts to the physical and biological aspects of the environment. This emphasis is reflected in our document. Because of public and management concerns about economic, social, and perceived health effects, we present them also, though they may not be required by NEPA.

How the Effects Were Estimated

In October and November of 1986 the interdisciplinary team identified the information needed to disclose and compare the environmental and management implications of the alternatives in this environmental impact statement.

Each alternative needed information that would show:

- the environmental effects (including effects on public health);
- the amount of work that would be done on the National Forests;
- the cost of that work; and
- the goods and services that the National Forests would provide.

How would an alternative be implemented on the National Forests of the Region? Scientific literature provides a basis for tracing the effects, results, and risks associated with specific activities. However, the extent to which those activities would be used in any single alternative

was not known.

What would be the mix of tools? Some vegetation management tools can be substituted for others, but their relative effectiveness varies, as do their implications for other resources and programs in the multiple-use mission of the Forest Service.

Information about the alternatives needed to incorporate an integrated view of resource management, and consider the ecology and the management goals of each National Forest. Estimates had to be made as to the levels of activities and outputs associated with the various alternatives.

Common definitions for the various vegetation management activities and resource and amenity outputs were essential. An activity identified on the Colville National Forest had to be comparable to one noted for the Rogue River National Forest, for instance. Likewise, there needed to be a common period used to compare the activities, costs, and effects associated with each alternative.

The need for common definitions was met by the Management Information Handbook, which provides a codified set of definitions for Forest activities and outputs. Information on the levels of cost associated with different activities and their related outputs are contained in the Forest's budget proposals. Information for these proposals was generated by the respective National Forests and validated, where necessary, through discussion with Regional Office specialists.

In total, these information requirements clearly indicated that the interdisciplinary team would need to work closely with the National Forests in the Region.

The interdisciplinary team chose the budget proposed for Fiscal Year 1989 as the baseline for data collection and analysis. It is the most current and comprehensive data base.

Alternative B is the summation of the individual Forests' 1989 proposed budget programs. It is the baseline for this analysis. The management and environmental consequences of implementing any alternative are expressed as differences from Alternative B.

The Fiscal Year 1989 budget proposal has the disadvantage of being a proposal. It has not yet gone through to final approval. Being pre-decisional, it is also confidential, and the specific dollar amounts and activity levels are not public information. Thus, some specific information about Alternative B is not presented in this Environmental Impact Statement, because to do so would be to disclose a budget proposal before it has been approved by the Administration. This in no way detracts from the analytical integrity of the analysis—all the information presented for the alternatives is fully comparable. What it does mean is that we can show how much more or less costly a

particular line item is for any alternative relative to Alternative B—but we cannot show the absolute dollar expenditure expected for Alternative B.

The budget level proposed for Alternative B is not substantially different from other budget proposals in recent years. It forms the basis for a realistic estimate of Forest programs. The environmental and management effects of the vegetation management alternatives relative to each other are not significantly affected by probable changes in the budget levels.

In December 1986, the interdisciplinary team sent a detailed questionnaire to each of the 19 National Forests in the Region. It contained an explanation of the work being done for this analysis; a presentation of the alternatives; a list of questions regarding vegetation management; a list of items needed to establish a detailed data base for analysis of fire and forest fuels; and the budget matrix for the 39 line items potentially involved with vegetation management activities. (In total, the questionnaire package comprised 54 pages. A copy as it was sent to the National Forests is available upon request from the vegetation management group. See the cover sheet of this document.)

The data from the Forests were examined in detail by specialists on the interdisciplinary team. Where clarifications were needed, or where data were inconsistent, the team specialists coordinated any needed revisions with the appropriate specialist(s) on the National Forests and cognizant resource specialists in the Regional Office. Regional Office resource managers played a key role in contributing to the team's understanding of their programs in the future.

The Regional consequences of the alternatives—both management and environmental—were developed from these data sources. The data were entered into electronic spreadsheets for analysis.

The different consequences of the alternatives are generally presented as Regional totals. This is appropriate to the scope of the document, as it establishes a Regional program. As previously noted, the environmental consequences for specific vegetation management projects will be analyzed in site-specific environmental analyses.

Incomplete or unavailable information was sometimes encountered in the process of preparing this EIS. The implications of these situations and how they were handled are discussed next.

Incomplete or Unavailable Information

The purpose of the environmental analyses contained in this EIS is to “present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and pro-

viding a clear basis for choice among options by the decisionmaker and the public” (40 CFR 1502.14).

Data and information collected for the various analyses in this EIS, as well as the resulting estimates of effect and conclusions, vary in precision and accuracy. Some are based on censuses and many mutually-confirming studies. Others are based on samples and a few studies; some are estimates by professional specialists drawing on extensive experience with individual disciplines. The standard for determining the depth of analysis is that analysis be sufficient to provide “a clear basis for choice among options”—in this case, a choice among the seven alternatives considered in this EIS.

Uncertainty in data and information is often the result of the inherent variability of natural phenomena. Uncertainty due to inherent variability can be expressed through a variety of means, including statistical measures of variation, estimates of ranges, and qualitative descriptions.

Sometimes, uncertainty is the result of incomplete or unavailable information. If the information that is incomplete or unavailable is essential to the decision to be made—in this case, selection of one of the seven alternatives considered in this EIS—then a more rigorous standard for analysis and reporting is required (40 CFR 1502.22). The more rigorous standard specifies an orderly, careful, and open professional approach in dealing with uncertainty. It is summarized in Figure IV-1 (next page).

An open public process was used in preparing this EIS to identify significant issues. Three of the seven issues identified are issues because of the potential for reasonably foreseeable significant adverse impacts on the human environment. The potential impacts are in the areas of human health, social and economic effects, and environmental effects. See Chapter I and Appendix I for discussions of the issues and the scoping process.

Vegetation management will affect the Forest Service’s ability to provide goods and services and payments to local governments. An alternative’s impacts on these can be reasonably estimated. These estimated effects are reported later in this chapter. The effect of these changes cause changes in employment and income. These can be estimated also; they are reported in the Social and Economic Effects section of this chapter. In the area of social and economic effects, there is sufficient information to provide a clear basis for making a choice among options with confidence.

Uncertain Data and Estimates

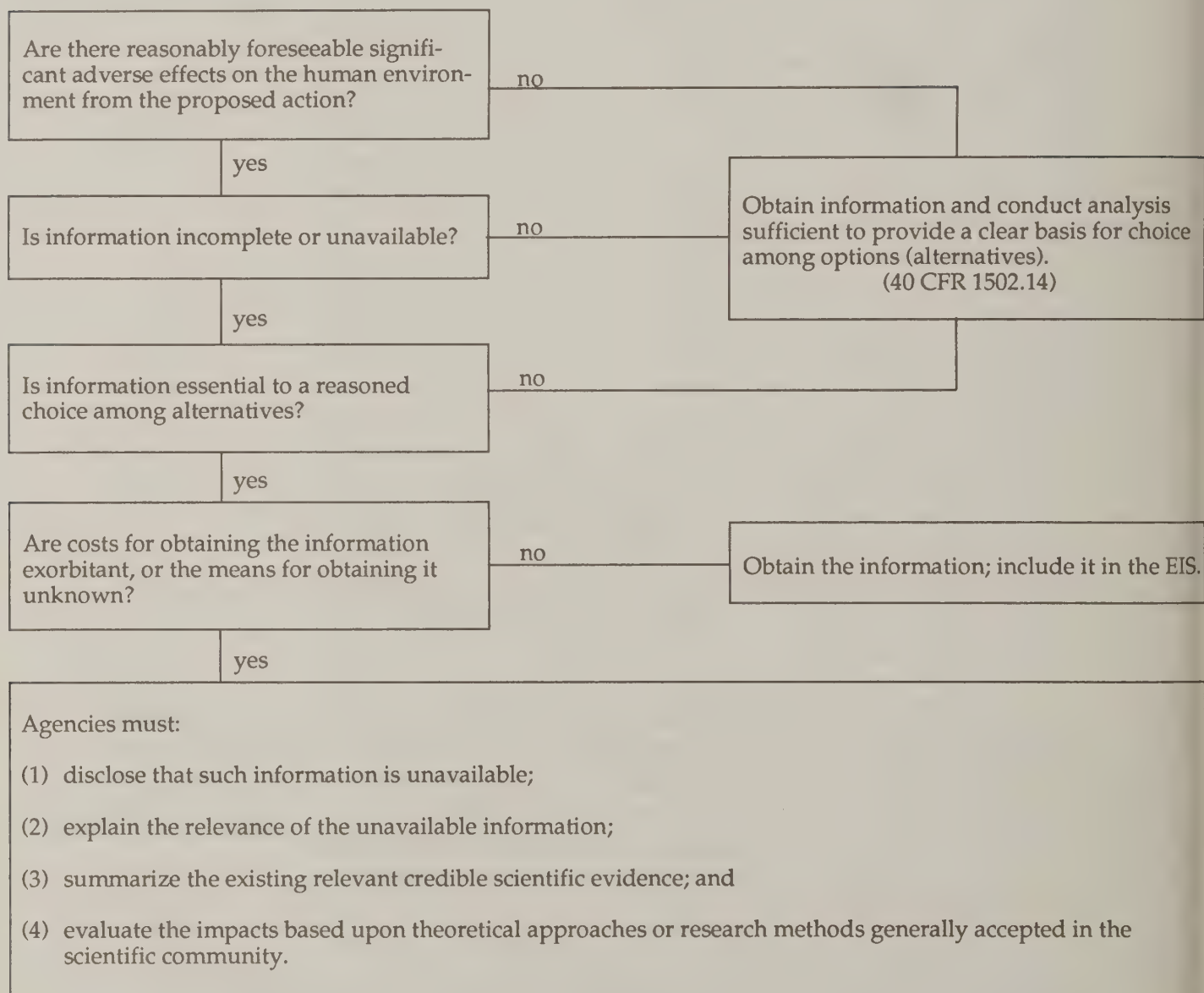
Reasonably Foreseeable Significant Adverse Effects

Economic Impacts

Figure IV-1

Incomplete Or Unavailable Information

(40 CFR 1502.22)



Environmental effects are reasonably well understood. The uncertainty associated with estimating environmental effects is due to the (often great) inherent variability and diversity associated with the natural environment. By using appropriate assumptions and professional judgment, effects of actions can be reasonably estimated with confidence. (These estimated effects are presented as the main part of this chapter.) While no estimate of effects for a given alternative is absolutely correct, the relative effects—compared to other alternatives—is correct. There is sufficient information with regard to environmental effects to provide a clear basis for choice among options.

Environmental Impacts

Human health concerns related to managing competing and unwanted vegetation have been the subject of controversy for many years. Safety of herbicides is the most controversial aspect of this issue. The health effects of smoke from burning has also emerged as an issue. The controversy in large part stems from the very fact that information is incomplete or unavailable. As a result, there are strongly differing—though still scientifically credible—opinions as to the human health effects of herbicides and of smoke. Therefore, the more rigorous standards identified in 40 CFR 1502.22 are applicable to analyses associated with human health effects of herbicides and of smoke.

Human Health Impacts

A detailed and systematic determination of the quality of available information for human health effects of herbicides is identified in the section on Human Health Effects in this chapter. Information that is incomplete or unavailable for human health effects of herbicides is summarized in Appendix H.

Incomplete or Unavailable Information

The costs of obtaining more precise and conclusive data were estimated and were found to be exorbitant. While there is incomplete and unavailable information, much information about the human health effects of herbicides does exist. A large portion of the information that does exist was developed in support of registration of herbicides by the Environmental Protection Agency.

Much information is incomplete or unavailable for human health effects of smoke associated with management of vegetation, slash burning, or wildfire. The state of the art for evaluating air toxics is relatively primitive, compared to the toxicology of pesticides. Information is incomplete or unavailable in the following areas:

- characterization of human exposures to smoke, including composition of smoke; concentration of its components; duration of exposures; and populations exposed;
- the toxicology of many of the constituents of smoke; and
- methodologies, generally accepted in the scientific commu-

nity, for characterizing human health risks from smoke from Forest-prescribed burns and wildfires.

Because the state of the art is new and relatively undeveloped, the means to obtain the necessary information are unknown. Costs of advancing the state of the art sufficiently to allow characterization of human health risk due to smoke are inestimably large, and therefore are exorbitant. The direct costs of delaying action until the information is obtained would be unacceptably large. Delay would also have undesirable impacts related to unemployment, travel accidents, and increased wildfire risk, as characterized by the effects of Alternative C.

Statement of Relevance

The relative human health effects of herbicides and smoke can be compared among alternatives. Comparisons are made in this EIS for accidents from manual control of brush; accidents from prescribed burns and wildfires; health effects from exposure to smoke; and health effects from exposure to herbicides (see the Human Health Effects section of this chapter, and the comparison section of Chapter II). The comparisons are based on the number of acres treated by various means for each alternative. All alternatives are compared to an alternative that approximates a likely future. The uncertainty for which there is incomplete and unavailable information is for the actual human health risks from herbicides and smoke associated with the agency's programs.

Summary of Information

Information that is currently available is summarized in several places in this EIS:

<i>Appendix H</i>	Human Health Risk Assessment (Qualitative)
<i>Appendix D, Section 3</i>	Hazard Analysis
<i>Appendix D, Attachment A</i> ...	Details of Mutagenicity and Carcinogenicity
<i>Chapter IV</i>	Human Health Effects

Evaluation of Impacts

The human health effects of the alternatives are compared in Chapter II. The detailed human health effects of the alternatives are discussed in Chapter IV. In the course of evaluating potential human health effects, three kinds of information were used—historical studies, research studies, and quantitative predictions.

Historical information, such as accident rates, was used to estimate comparative effects of alternatives, using the alternative that most closely approximates the historical programs as a baseline.

Many research studies (see listings in Appendices D and H) were used to determine what effects are currently known. A great

number of research studies have been conducted on the use of herbicides, many in support of registration by the Environmental Protection Agency. Enough information is available that risk can be reasonably characterized for all herbicides being considered except two, diuron and fosamine. Quantitative estimates of risk are contained in Appendix D, which is a detailed quantitative human health risk assessment that considers four different scenarios: (1) routine-worst case; (2) routine-realistic; (3) accidental spills; and (4) accidental spraying. An estimated level of confidence that no adverse human health effects will occur for each herbicide being considered for use is shown in Tables IV-24 through IV-26, this chapter.

Considerably less research information is available for the human health effects from smoke associated with the management of competing and unwanted vegetation. As noted above, in addition to not being able to characterize exposures, and having very limited data on toxicology of all of the constituents of smoke, methodologies for characterizing human health risks from smoke associated with vegetation management have not been developed. Effects of smoke were evaluated using the limited information and estimates currently available.

With the exception of no action, the risks to humans associated with the management of vegetation is more closely correlated to the number of acres treated, rather than to what tool is used. All vegetation management activities pose some risk to human health: the more work done, the more risk incurred.

Consideration of risk can take two forms—risk assessment, and risk management. The process of risk assessment by government agencies was studied by the National Research Council Committee on the Institutional Means for Assessment of Risks to Public Health ("NRC Committee"). The Committee noted that:

"Risk assessment is an analytic process that is firmly based on scientific considerations, but it also requires judgements to be made when the available information is incomplete. These judgements inevitably draw on both scientific and policy considerations." (NRC Committee, 1983, p.48.)

"Risk management is the process of weighing policy alternatives and selecting the most appropriate regulatory action, integrating the results of risk assessment with engineering data and with social, economic, and political concerns to reach a decision." (NRC Committee, 1983, p. 3.)

This EIS assesses risk. It provides information for making strategic decisions about the management of risks by selecting one of the alternatives and develops guidelines for the management of risk for deriva-

tive vegetation management projects. One mitigating measure developed as part of this EIS is that all subsequent derivative vegetation projects will include the development of a Human Health Risk Management Plan (see Chapter II, Methods and Mitigating Measures) to assure the consideration and protection of human health in all vegetation management projects.

Chapter 4

Environmental Consequences

- Geology
- Climate
- Soil
Resources
- Fire
- Air
- Water
Resources

Geology

Geology interacts either directly or indirectly with all other environmental factors. For example, serpentine exerts a major influence in controlling soil development, species composition, and growth rates. Soil moisture retention is indirectly related to the geologic material and how it weathers. However, the implementation of alternatives and the application of methods considered in this environmental impact statement are not expected to affect the geology.

Climate

The climate interacts with all other environmental components directly and indirectly, but vegetation management activities are not expected to have significant or cumulative effects on the Regional climate. Although plants play a major role in the carbon dioxide/oxygen balance, the effects of any reduction in vegetation on the climate are thought to be insignificant.

Local, site-specific microclimate changes are expected. The degree of change depends on the intensity, frequency, and extent of the application, and the specific method used. Generally, chemical, biological, and manual methods have low impacts on the soil surface, compared to mechanical and thermal methods. Disruption of the soil surface can change the site's ability to transfer heat and water and result in an increase in temperature extremes. Burning blackens the surface and changes radiation input (refer to the discussion on the effects on soils). Local microclimate changes are dealt with locally in silvicultural plans.

Soil Resources

Site disturbance caused by manual methods of vegetation management (such as manual cutting of brush for rights-of-way clearing or conifer release; hand scalping for site preparation; hand pulling of weeds; and hand piling of slash) is usually negligible. The duff layer is usually not affected, or is only disturbed in a very small area. If large areas are cleared of duff and debris on steep slopes, there is a potential for accelerated erosion. However, the amount of vegetation removal by manual methods is usually not sufficient to cause substantial impacts on the soil resource.

Manual Methods

Table IV-1

Acres (Thousands) Manually Treated Each Year

(Includes site preparation and release, fire management, range improvement, noxious weed control, and wildlife habitat improvement activities.)

<i>Alternative</i>	A	B	C	D	E	F	G
East-side Forests	39.0	43.0	5.5	25.9	56.3	38.5	46.4
West-side Forests	47.3	21.6	7.0	25.5	26.7	29.6	27.2
Totals	86.3	64.6	12.5	51.4	83.0	68.1	73.6

Table IV-2

Miles (Thousands) Manually Treated Each Year

(Includes roadside and trail maintenance activities.)

<i>Alternative</i>	A	B	C	D	E	F	G
East-side Forests	3.9	4.0	2.0	2.3	3.6	3.5	3.5
West-side Forests	4.6	4.8	1.5	2.0	4.4	4.5	4.5
Totals	8.5	8.8	3.5	4.3	8.0	8.0	8.0

Mechanical Methods

The majority of acres treated by mechanical methods involve tractor piling of slash (for site preparation or fuels treatment), or scarification (for site preparation). Mechanical brushing for roadside clearing is not included in Table IV-3 because equipment is operated from an established roadway, and thus has low potential for effects on the soil.

Potential Direct and Indirect Impacts. Tractor piling of slash or scarification for site preparation can cause soil compaction, puddling, and surface erosion. Disturbing the duff layer and removing organic material can also lead to a reduction in site productivity. These adverse impacts can be prevented or minimized by proper use of

Table IV-3

Acres (Thousands) Mechanically Treated Each Year

(Includes roadside and rights-of-way brushing activities.)

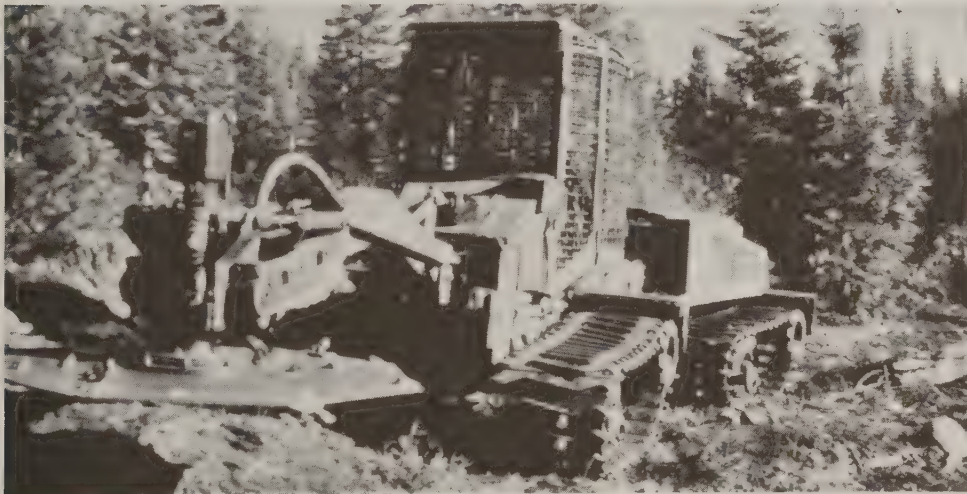
<i>Alternative</i>	A	B	C	D	E	F	G
East-side Forests	126.6	132.4	26.9	85.8	123.1	134.6	118.7
West-side Forests	40.8	28.6	8.9	18.4	34.5	58.8	27.9
Totals	167.4	161.0	35.8	104.2	157.6	193.4	146.6

equipment and care in timing of activities (see Ch. II, Mechanical Methods, Mitigation Measures).

Discussion. Mechanical methods involve ground disturbance, and have the highest potential of any method of vegetation management for direct impacts on soils (Newton and Norgren 1977). Soil disturbance from scarification and construction of tractor trails causes compaction (Froehlich 1973). Compaction can lead to a decrease in rooting depth, which can result in reduced shoot or leader growth.

The long-term effects of compaction are unknown, but it may cause a reduction in soil productivity (Froehlich 1973) and inhibit extension of mycorrhizal fungal mycelia (Perry and Rose 1980). Mycorrhizal fungal mycelia are important for nutrient uptake.

Detrimental compaction primarily occurs when soils are wet. It can be minimized by restricting operations to dry seasons or choosing other methods on critical soils.



Mechanical site disturbance has the highest potential of any vegetation management method for direct impacts on soils.

Mechanical site disturbance may also remove some of the protective duff layer. In combination with compaction, this may increase the potential for surface erosion, especially on steeper slopes. Accelerated erosion removes the productive topsoil and leads to a loss in site productivity. Therefore, wheeled and tracked equipment is limited to slopes under 35 percent, as specified in Forest Service Manual 2520 (see Chapter II, Mechanical Methods, Mitigation Measures).

Yarding of unmerchantable material (YUM) involves removing residue that, left undisturbed, would be available to decompose and supply organic matter and nutrients to the soil. While site disturbance from this procedure is usually minimal, the removal of large volumes of organic matter from a site could affect nutrient cycling and long-term productivity.

Conclusion. There is some potential for long-term effects on soil productivity and nutrient cycling from removal of organic material due to yarding of unmerchantable material, disturbance of the duff layer, or compaction.

Adverse effects on the soil caused by mechanical methods of vegetation management can largely be prevented by attention to site-specific conditions such as slope, soil moisture content, and duff layer, as described in the Mitigation Measures for Mechanical Methods section of Chapter II. Selection and operation of equipment is also important in prevention of adverse impacts on the soil resource. Mitigation measures for implementation of mechanical methods are the same for all alternatives, varying only in the number of acres affected.

Alternatives A, B, E, F, and G involve similar levels of mechanical methods of vegetation management. Thus, they have similar impacts on soil resources.

Alternative D would mechanically treat 64 percent of the acres treated under Alternative B, with a corresponding reduction in potential for impacts on the soil. Alternative C, the "no action" option, would mechanically treat 20 percent of the acres treated using this method under Alternative B.

Prescribed Burning

Prescribed burning includes broadcast burning, burning of residue in piles, and underburning.

Potential Direct and Indirect Effects. Burning can adversely affect the duff layer leading to surface erosion and reduced site productivity. An excessively severe burn may also alter the soil microbial community. Accelerated mass wasting (soil and rock slides or flows) on steep slopes after shrubs are burned may also be an indirect effect.

Discussion. Loss of organic matter may be the most important fire effect. Some of the nutrient capital held in the logging debris, litter, duff, and soil is volatilized during burning and is leached from the ashes (Kraemer and Hermann 1979).

Table IV-4

Acres (Thousands) Thermally Treated Each Year

(Includes site preparation and release, precommercial thinning, natural and activity fuels treatment, and wildlife habitat improvement activities.)

Alternative:	A	B	C	D	E	F	G
East-side Forests	157.0	154.4	0	91.4	151.1	119.9	152.4
West-side Forests	60.8	55.5	0	34.4	42.7	55.9	62.6
Totals	217.8	209.9	0	125.8	193.8	175.8	215.0

Depending on the temperatures produced, 30 to 90 percent of the nitrogen in the organic materials may be lost from the site immediately. Persistent, deep burning slash fires will cause additional losses of nutrients during the first few years after burning (Sidle 1980). A fire which heats the soil to temperatures above 100 degrees Centigrade will temporarily alter the microbial community and trigger a pulse of surface erosion. The alteration of the microbial community caused by burning may also affect the rate of nutrient cycling (Perry et al. 1985).

The amount of surface erosion is generally proportional to the severity of the burn as measured by the amount of exposed inorganic soil (consumption of the forest floor). Burn severity is controlled by fuel loading, fuel moisture content, and soil moisture content (Bennett 1982). Relatively unproductive sites, such as those on steep (greater than 60 percent) slopes, with shallow organic layers, or high erosion potential, are the most vulnerable to damage from excessively hot fires (Perry et al. 1985).

A severe burn on a dry site may cause a water-repellent layer to form beneath the soil surface. This layer blocks the infiltration of water into the soil (Sidle 1980), and can cause accelerated erosion. However, experience in the Pacific Northwest Region has shown this condition to be an infrequent effect of burning.

The effects of burning on slope erosion will generally persist for only one season, but may last longer on harsh sites where vegetation is slow to recolonize.

Indirect effects of burning caused by removal of the litter layer include reduced infiltration and water storage capacity, with consequent increased runoff and erosion potential. Once organic matter is consumed, the stability of soil aggregates is lost and dry ravel (crumbling and downslope movement of the surface layer of soil) occurs (Everest and Harr 1982). Single-grained soils—such as those derived from granitic material or volcanic ash—are most susceptible to surface erosion following burning.

Following burning, increased mass wasting (movement of soil and rock due to gravity, including rock slides, debris avalanches, and earth flows) may occur on sites steeper than 60 percent that are prone to mass failure. Loss of root strength and reduction in evapotranspiration due to loss of residual vegetation after burning can result in such instability. However, timber harvest and road construction are likely to be more important activities in affecting the occurrence of mass failures on such sites.

Machine piling of logging residues or crushing of vegetation is sometimes used to concentrate fuels prior to burning. This practice is restricted to slopes of less than 35 percent. There is a danger of causing heavy damage to the soil beneath burn piles due to the high soil

temperatures resulting from fire burning in one place for an extended period. However, the damaged area is seldom greater than a small percent of the total area. According to Forest Service Manual 2520, a minimum of 80 percent of an activity area must be left in a condition of acceptable productivity (see Chapter II, Mechanical Methods, Mitigation Measures).

Broadcast burns for hazard reduction and site preparation have the highest potential for damage on sites with single-grained soils and thin duff layers. Prescribed burning conducted for range and wildlife habitat improvement are generally of lower severity due to smaller fuels and the resulting rapid passage of the fire.

To prevent complete destruction of the litter layer and minimize the amount of organic material lost during the burn, fuel moisture, soil moisture, and fuel loading are considered in the timing of a burn (see the Chapter II section on mitigation measures for prescribed burning).

Conclusion. The potential for detrimental effects on soils due to burning exists on steep slopes; southern exposures (when a large proportion of the organic litter and duff layers are removed); single-grained (granitic) soils; and from excessively hot burns. Actual effects are highly dependent on site conditions, which vary tremendously throughout the Region.

A site-specific, project-level analysis is required by all alternatives in this EIS to assure that prescribed burning is done only under conditions which prevent removal of more of the organic layer than is absolutely necessary.

Alternatives D, F, and C show substantial reductions in acres treated with prescribed fire. There may be a substantial increase in wildfires in the future, particularly with Alternative C (see Fire, this chapter).

Biological Methods

Grazing of sheep and cattle is the major biological technique used in the Pacific Northwest Region. Other techniques, such as release of insects which selectively feed on or damage target weeds, are used in limited areas, in cooperation with the USDA Agricultural Research Service and various state agencies.

Grazing of sheep and cattle for site preparation and release occurs primarily on East-side Forests in a limited number of plantations. Prolonged or forced grazing by cattle has been primarily an East-side technique, while use of sheep has been concentrated in the Coastal area. Acreage grazed within range allotments for production of livestock is not part of the vegetation management program.

Due to the limited number of acres involved and the close

Table IV-5

Acres (Thousands) Grazed Annually

(Site preparation and release activities.)

<i>Alternative:</i>	A	B	C	D	E	F	G
East-side Forests	11.4	0.8	0	14.1	2.3	5.2	2.8
West-side Forests	3.4	3.5	0	4.6	3.6	3.1	4.1
Totals	14.8	4.3	0	18.7	5.9	8.3	6.9

control of livestock needed to prevent damage to desired conifers, there is low potential for soil damage due to compaction. In wet areas subject to compaction and trampling, grazing is not the method of choice.

Other biological methods of vegetation management—such as seeding roadsides with desired species—can have beneficial effects on soils. The protective cover of vegetation will prevent soil erosion and add organic material to the soil.

Herbicides may be applied aerially, by truck-mounted or backpack sprayers, or by stem injection. Tables IV-6 and IV-7 display the acreage likely to be treated each year in different activity areas under the alternatives.

Herbicides

Table IV-6

Acres (Thousands) Treated With Herbicides Each Year

(Includes silviculture, range improvement and noxious weed control.)

<i>Alternative:</i>	A	B	C	D	E	F	G
East-side Forests	0	15.7	0	11.0	16.3	23.9	27.1
West-side Forests	0	34.3	0	7.1	21.4	31.1	37.3
Totals	0	50.0	0	18.1	37.7	55.0	64.4

Table IV-7

Miles (Thousands) Treated With Herbicides for Road Maintenance Each Year

(Forest Service applications.)

<i>Alternative:</i>	A	B	C	D	E	F	G
East-side Forests	0	1.4	0	0.9	1.3	1.3	1.7
West-side Forests	0	5.1	0	4.9	5.5	4.8	6.4
Totals	0	6.5	0	5.8	6.8	6.1	8.1

Potential Direct and Indirect Effects. The persistence of herbicides in the soil depends on chemical properties, climatic factors, soil properties, and initial rate of application. Many soil microorganisms are capable of breaking down these herbicides. However, adverse effects on soil microorganisms have also been reported.

Discussion. Though much of the herbicide applied falls on foliage, the soil is a major receptor for herbicides, whether applied aerially or by truck-mounted and backpack units.

Soil and the forest floor form an active biological system that decomposes herbicides. Herbicide degradation is usually biological (EPA, 1980). In the forest, herbicides generally are immobilized quickly and almost completely (Norris et al. 1983). Warmer temperatures during periods of adequate moisture generally favor decomposition by microbes.

Persistence is the predominant factor affecting a herbicide's presence in the environment. Climatic factors and soil properties of the particular site—in addition to the characteristics of the particular chemical—also influence the actual length of time a herbicide remains in the soil.

Soils high in clay and organic matter can prevent movement of herbicides (due to leaching) by providing sites for adsorption (adhesion onto the surface of a particle) and absorption (incorporation into a particle) of chemicals. Soils with low pH also tend to increase adsorption. Areas with abundant rainfall increase the chance of mobilization of herbicides by leaching or runoff.

Table IV-10, Comparison of Herbicides, provides a relative comparison of the 16 herbicides approved for Forest use. The two most commonly used herbicides, 2,4-D and glyphosate (used on 60 percent of the acres treated), each have a fairly short half-life. (The half-life is the average time it takes for 50 percent of the chemical to disappear.)

In warm, moist, loam soils, 2,4-D can be expected to decompose within 2 to 3 weeks (Loos 1976 in Lorz 1979). Studies in the Coast Range (Perry and Rose 1980) report a half-life of 29 days in litter-covered soil, and 40 days in bare soil for glyphosate.

Application of triclopyr, atrazine, and picloram constitute another 20 percent of the acres treated. The half-life of triclopyr is strongly dependent on soil conditions and climate. Its half-life may be up to 46 days (USDA-Forest Service 1984). Norris et al. (1987) measured a 50 percent loss of triclopyr in 3.7 days and a 90 percent loss in 40 days in western Oregon.

Most herbicides seem to persist longer in cold, arid climates. The half-life for atrazine has been reported to vary from 3 to 12 months; while picloram has been reported to have a half-life anywhere from 1 month to 4 years in arid conditions (USDA-Forest Service 1984).

Many soil microorganisms can metabolize herbicides, and are often reported to be responsible for herbicide decomposition (Norris et al. 1981). However, there may be adverse effects on microorganisms. Experimental tests yield widely varying results, from toxic effects to stimulation of certain populations.

Use of herbicides does not involve removal of vegetation from the site, but instead results in a pulse of dead organic matter on the site. Due to subsequent decomposition and release of nutrients, the impact on the nutrient pool may be negligible if soil microorganisms are not affected.

Under Alternatives B and G, approximately 500 acres would receive what is commonly called “brown and burn” treatment. This practice involves aerial spraying of vegetation with herbicides in order to desiccate it. Five to seven months later, the site is broadcast burned. “Brown and burn” treatments are limited to the steep, brushy, hardwood-covered terrain found in the Oregon Coast Range. The herbicides used are typically 2,4-D, glyphosate, and triclopyr.

Since the half-life for each of these herbicides is well under two months (see Table IV-10), most of the chemical will be degraded prior to broadcast burning. Degradation would occur primarily from microbial action, which should occur rapidly in the warm, moist conditions typically found on these sites. Therefore, effects on the soil would be the same as for the individual effects of broadcast burning and application of herbicides.

Conclusion. Adverse effects on the soil from use of herbicides for vegetation management will be minimized by adherence to the mitigation measures described in Chapter II, Herbicides. These measures apply to all alternatives that involve use of chemicals. Note that most (90 percent or more) of the herbicide used will be intercepted by foliage, and thus will not reach the soil until it is mostly decomposed.

Alternatives A and C, which prohibit use of herbicides, would pose no risk of adverse impacts on the soil from the use of chemicals. Alternative D would result in the smallest acreage chemically treated, followed by increasing acres in Alternatives E, B, F, and G.

Cumulative impacts are “the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions” (CEQ Reg. 40 CFR 1508.7). A cumulative impact occurs if effects do not return to pretreatment levels prior to the next action.

For example, if a site is compacted by tractor piling of slash, but recovers (through freeze and thaw, or the action of roots and burrowing animals) prior to the next entry, then that is an individual impact,

Cumulative and Synergistic Effects

not a cumulative impact. However, if the site remains compacted and another entry occurs, the effect accumulates at each entry.

Due to the synergistic nature of these interrelated effects, the cumulative effect may be more than the sum of the individual effects.

Potential Cumulative Effects

Potential cumulative effects on soils (due to the effects of past or future management on a site combined with vegetation management) include decreased site productivity, increased mass wasting, and buildup of chemicals in the soil. Table IV-8 displays the total acres treated annually for vegetation management by method, with possible adverse impacts on soil.

Table IV-8

Acres (Thousands) Treated Each Year Using Methods With Possible Impacts on the Soil Resource

Alternative:	A	B	C	D	E	F	G
Herbicides ¹	0	59.8	0	26.8	47.9	64.1	76.5
Mechanical ²	167.4	161.0	35.8	104.2	157.6	193.4	146.6
Biological	14.8	4.3	0	18.7	5.9	8.3	6.9
Prescribed Fire	217.8	209.9	0	125.8	193.8	175.8	215.0
Totals	400.0	435.0	35.8	275.5	405.2	441.6	445.0

¹ Includes rights-of-way, trail, and roadside miles, converted to acres.

² Does not include roadside and rights-of-way brushing.

Discussion. Disturbance of the duff layer and loss of woody material by mechanical or thermal methods after timber harvest may contribute to reduced long-term site productivity. Removal of shrubs by mechanical, thermal, or chemical methods following timber harvest may also affect nutrient cycling, but vegetation management usually does not have severe enough effects to cause a significant impact.

Removal of nitrogen-fixing plants (such as red alder) may have a substantial impact. Far more nitrogen is removed in harvest and site preparation than is added by natural sources other than alder (Perry et al. 1985). Perry also states that red alder may suppress the pathogen *Phellinus weirii*.

Some impacts on soils occur from removal of vegetation, regardless of the method employed. Removal of vegetation cover can cause 1) an increase in soil moisture due to reduction of evapotranspiration; 2) changes in snow accumulation patterns; or 3) loss in root strength. These can lead to increased mass wasting on steep slopes.

Trees are the dominant forces in soil stability, but shrubs may

play a role when trees are removed. However, vegetation management results in a temporary setback of shrubs, not elimination of them. Other activities, such as construction of roads and removal of timber on steep slopes, have the primary impacts on slope stability (EPA 1980). The additional increase in instability due to removal of competing vegetation is negligible in comparison.

Repeated applications of herbicides may occur for road maintenance, site preparation and release, genetic tree improvement, noxious weed control, range improvement, facilities maintenance, and rights-of-way maintenance. A buildup of herbicide residues in the soil is possible if repeated applications occur before sufficient time passes for the previous application to break down. However, the time interval between applications of herbicides on National Forest lands usually exceeds the time required for decomposition.

The acreage involved in repeated application is small. Treatments occasionally occur annually, but more often every 2 to 7 years. Annual treatments are usually on a spot basis. Application of herbicides for site preparation and release may occur within 2 to 8 years on a site, but repeated applications within a year would occur on less than 100 acres in the Region. Over the course of a timber rotation (80 to 120 years), more than three applications to the same area are rare.

Application of herbicides may occur every other year on 2,200 acres of seed orchards and evaluation plantations in the Region. For noxious weed control and range improvement projects, a maximum of 5,690 acres (on East-side Forests) could receive annual applications for 2 to 4 years.

The persistence of the specific herbicide used and its susceptibility to water transport, local environmental conditions, and the rate and frequency of application determine the potential for buildup of residues in the soil.

For 80 percent of the acreage treated, the herbicides used (2,4-D, glyphosate, triclopyr, picloram, and atrazine) persist less than one year under conditions typical of the Region. For limited acreages involved in rights-of-way, roadsides, and rangeland treatments (where annual treatments may occur repeatedly) there may be a potential for buildup of herbicides.

Synergistic effects of herbicides are those that occur because of application of more than one herbicide, where the combined effect of the chemicals is greater than the sum of the effects of each agent alone.

The effects of the many possible combinations of herbicides have not been studied. The majority of vegetation management projects involve use of a single herbicide. The herbicide formulations used are combinations approved by the EPA. Since the choice of herbicide is

Potential Synergistic Effects

determined by site characteristics and vegetation present, it is unlikely that a site would be sprayed with many different herbicide formulations for different purposes.

Conclusion. Project-level analyses will consider the potential cumulative impacts on soils in all alternatives. Vegetation management activities are usually part of a larger overall project. Thus the effects of managing competing and unwanted vegetation will be analyzed along with the effects of the other management activities.

All alternatives meet direction for protection of soil resources in existing and projected Forest land management planning documents and Forest Service Manuals. The alternatives will also meet or exceed the requirements for protection of soil resources found in Washington, Oregon, and California Forest Practices Acts.

Changes in soil productivity or erosion will have effects on vegetation, water quality, channel stability, and fisheries resources. See the discussions on water resources, forest and range ecosystems, and fisheries resources in this chapter.

Table IV-9

**Recommended Concentration Maximums for Silvicultural Chemicals
by Stream Class and User Group.**

Potable waters include safety factors for wildlife and aquatic organisms as well as humans.
(from Newton and Norgren 1977)

Chemicals	Most Sensitive Species Affected	Test Basis & Concentration	Criteria, ppm 24-hour Mean Stream Class & User					
			≤ 10 cfs		10 cfs—Navigable		Navigable	
			Potable	Irrigation	Potable	Irrigation	Potable	Irrigation
<i>Amitrole</i>	Daphnia	LC ₅₀ 48 h 3 mg/L	.15	.1	.03	.01	.015	.01
<i>2,4-D</i>	Bluegill	LC ₅₀ 48 h 1.0 mg/L	.05	.05	.05	.02	.01	.005
<i>Dalapon</i>	Daphnia	LC ₅₀ 48 h 11.0 mg/L	.5	.1	.1	.02	.10	.02
<i>Dicamba</i>	Bluegill	LC ₅₀ 96 h 23 mg/L	.2	.004	.05	.002	.01	.001
<i>Picloram</i>	Bass	LC ₅₀ 48 h 19.7 mg/L	.5	.001	.05	.0005	.005	.0001
<i>Triazines</i> ¹	Daphnia	LC ₅₀ 48 h 1.0 mg/L	.05	.05	.03	.03	.01	.01

¹Group of herbicides including diazine and simazine.

4 Environmental Consequences

Table IV-10

Comparison of Herbicides

CHEMICAL	Amitrol	Asulam	Atrazine	Bromacil	2,4-D & 2,4,DP	Dalapon	Dicamba
Persistence	short-med. (1,2,6)	short (2,6)	long (2)	med.-long (2)	short (1,3,5)	short (2,6)	med. (1,6)
Adsorption to Soil Particles	strong, but reversible (1,2)	negligible (2)	readily, but not strong	low (2)	not strong (2,5)	none (2)	none (2)
Solubility in Water	high (2)	**	low (1)	high (2)	high-acid, salt, low-ester form (5)	high (2)	high (2)
Mobility	moderate	moderate	moderate	high	moderate	moderate	high
Acute Toxicity	low (9)	low (2)	high (2)	low (7)	high-ester low-salt (9)	low (9)	low (9)

(Note: numbers in parentheses refer to references at the end of this table.)

PERSISTENCE—short = half-life less than 1 month; med. = half-life 1–6 months; long = half-life greater than 6 months; varies with climate and formulation

ADSORPTION—adhesion of the chemical onto the surface of soil particles.

SOLUBILITY—low = less than 500 milligrams per liter (mg/L); high = greater than 500 mg/L; will vary with environmental conditions and formulation.

MOBILITY—an evaluation of the chemical's susceptibility to transport by water, based primarily on persistence, with consideration given to strength of adsorption to soil particles and water solubility. Environmental conditions, timing of application in relation to rainfall, and distance to surface or groundwater will affect actual concentrations reaching a water source.

RELATIVE ACUTE TOXICITY TO FISH—the lowest 96-hour LC_{50} value (concentration that killed 50 percent of the test organisms within a 96-hour period) found in the literature for a fish species, where low = greater than 10 parts per million (ppm); mod. = 1–10 ppm; high = less than 1 ppm (based on classification by Clark et al. 1970).

Toxicity is influenced by environmental conditions such as water quality; life stage of the fish species tested; and conditions of the test, such as static or flow through. Other aquatic organisms may be more or less susceptible to a chemical than the fish species reported, and sublethal effects may occur at much lower concentrations. The purpose of this column is to provide a relative comparison among the chemicals.

<i>Diuron</i>	<i>Fosamine</i>	<i>Glyphosate</i>	<i>Hexazinone</i>	<i>Picloram</i>	<i>Simazine</i>	<i>Tebuthiuron</i>	<i>Triclopyr</i>
med. (2)	short (2,3,5)	short-med. (2,4)	med.-long (3)	long (2,6)	long (2,6)	long	mod. (2,6)
readily to clays and organic matter (2)	strong (2)	strong (2)	low (10)	low, to organic matter (2,5)	readily (2,8)	to organic matter and clays (2)	not strong (2)
**	high (3,5)	high (3,5)	high (3)	high (2,5)	low (2)	low (2)	**
moderate	low	low to moderate	high	high	mod.	mod. to high	mod. to high
high (10)	low (9)	mod. (2) Roundup, low	low (9)	mod. (9)	high (2)	high (2)	low (9)

** Data reviewed was insufficient to evaluate this characteristic.

- (1) Lorz, Harold W. et al. 1979. *Effects of Selected Herbicides on Smolting of Coho Salmon*, EPA-600/3-79-071.
- (2) USDA-FS, 1984-6. *Pesticide Background Statements Vol. Herbicides*, Agric. Handbook No. 633 and Supplements.
- (3) Norris, L.A. 1982. *The Behavior of Herbicides in the Forest Environment and Risk Assessment*. Proc. John S. Wright For. Conf., IN.
- (4) Perry, D.A., and Rose, S.L. 1980. *Productivity of Forest Lands as Affected by Site Preparation*. Presented at the CA Conf. on Forest Tree Nutrition and Soil Fertility, May 19-20. Redding, CA.
- (5) Norris, L.A. et al. 1983. *Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America: 9. Forest Chemicals*. General Technical Report PNW-149.
- (6) Newton, M., and Knight, F.B. 1981. *Handbook of Weed and Insect Control Chemicals for Forest Resource Managers*, Timber Press.
- (7) *Science Chapter: Bromacil, Ecological Effects*, 1982. Unpublished EPA document.
- (8) *Science Chapter: Simazine, Environmental Fate and Exposure*, 1983. Unpublished EPA document.
- (9) Mayer, F.L., Jr., and Eilersieck, M.R. 1986. *Manual and Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals*. USDI Fish and Wildlife Service Resource Publication 160. Washington, D.C.
- (10) *Registration Standards for Hexazinone, Environmental Fate*. Feb., 1982. Unpublished EPA document.

Fire

Prescribed Fire and Wildfire

Fire has always been a part of the natural ecosystem and an important factor in establishing the character of the affected site.

Potential Direct and Indirect Effects. Vegetation management is a recognized, effective approach for reducing the risk and severity of wildfires on forested lands. Changes in the vegetation management programs (as presented in the alternatives) are therefore expected to affect the occurrence and severity of wildfires.



Fire in the wilderness is also a concern. It has always been part of the natural ecosystem and an important factor in establishing the present character of each wilderness. Some wildernesses have approved fire plans now; all others will have approved plans as part of individual Forest Plans.

Management direction regarding fire in the wilderness is to allow fire to play its natural role within specified limits—such as protection of property values and resource values. (See the section on fire in chapter III for more information.)

Discussion. Cramer (1974) attributed the reduced amount of acres burned by wildfire in the southern United States to increased use of prescribed fire. In the Pacific Northwest, fuel hazard abatement, coupled with increased efficiency in fire suppression, have reduced wildfire acreage (Tiedemann 1978).

Statistics compiled by the Washington Department of Natural Resources (DNR) for the years 1973-1977 indicate that 44 percent of wildfires occurring on DNR-protected lands started in untreated logging and thinning slash. An additional 20 percent of the wildfires

were aided in their spread by burning through untreated slash (Geomet, Inc. 1978).

On the other hand, a significant proportion of the wildfires and acreage burned by wildfires on National Forests are attributed to escaped prescribed fires. From 1974 through 1984, escaped slash fires accounted for 7.5 percent of the wildfires and 27 percent of the burned acreage. Escaped slash fires average 34 acres in size. Compare this figure to the average of 10 acres burned for all human-caused wildfires.

Conclusion. Table IV-11 and Figures IV-2, IV-3, and IV-4 show that, for all alternatives except G, an increase in acres treated with prescribed fire results in a net decrease in the expected acres burned by wildfire. Conversely, a decrease in area treated with prescribed fire results in a net increase in the expected acres burned by wildfire.

Table IV-11

Expected Area Burned In the First and Fifth Decades by Alternative.
(In thousands of acres per year.)

Alternative:	A	B	C	D	E	F	G
<i>Wildfire*</i>							
Decade 1	0	Ref.**	+9	+5	0	+2	+1
Decade 5	-3	-3	+25	+9	-1	+6	-2
<i>Prescribed Fire</i>	22	22	0	14	20	12	24

*Average annual loss 1971-1986 was 17,000 acres.

**Reference—The wildfire losses expected with implementation of the applicable land and resource management plans.

Figure IV-2

Expected Acres Burned by Wildfire / Pacific Northwest Region

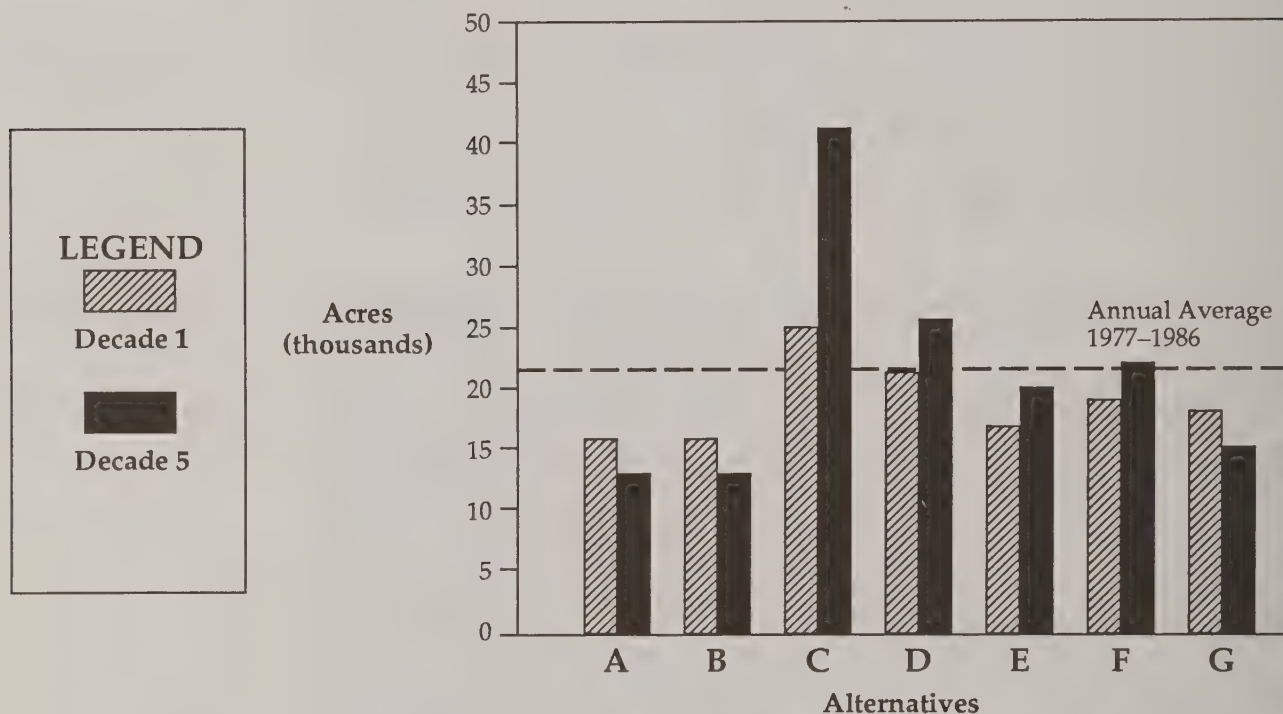


Figure IV-3

Expected Acres Burned by Wildfire / East-side

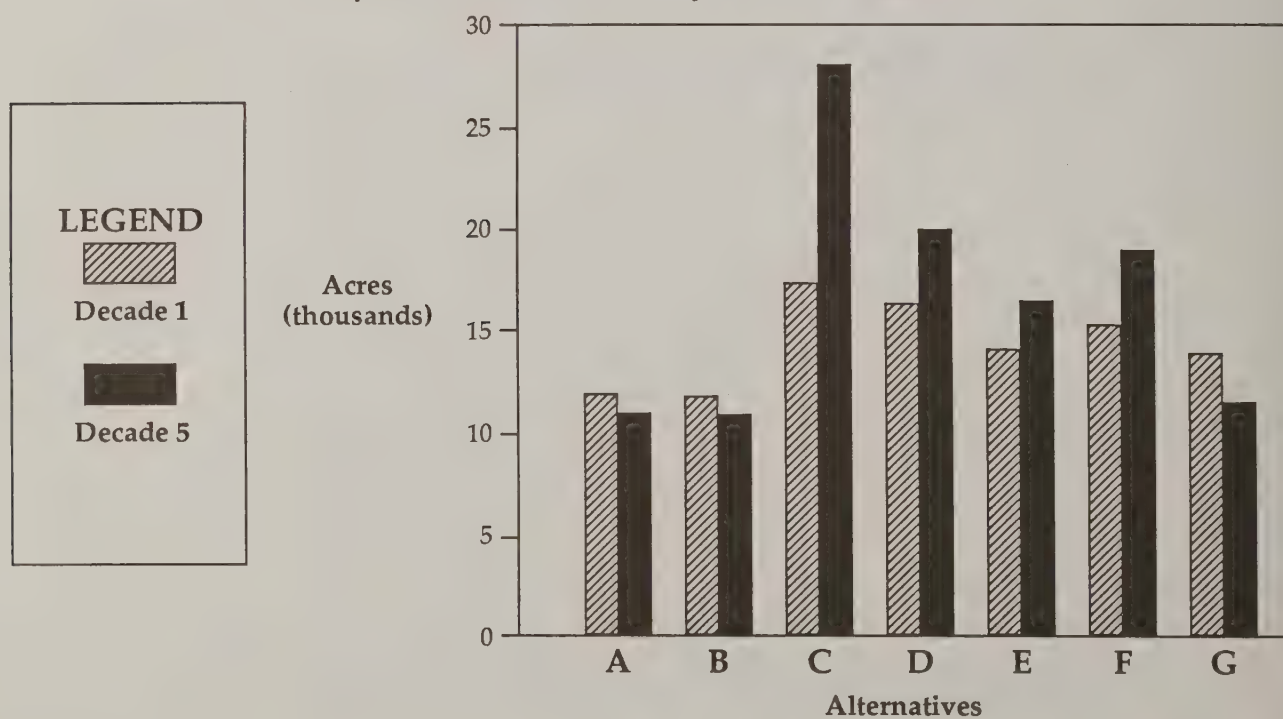
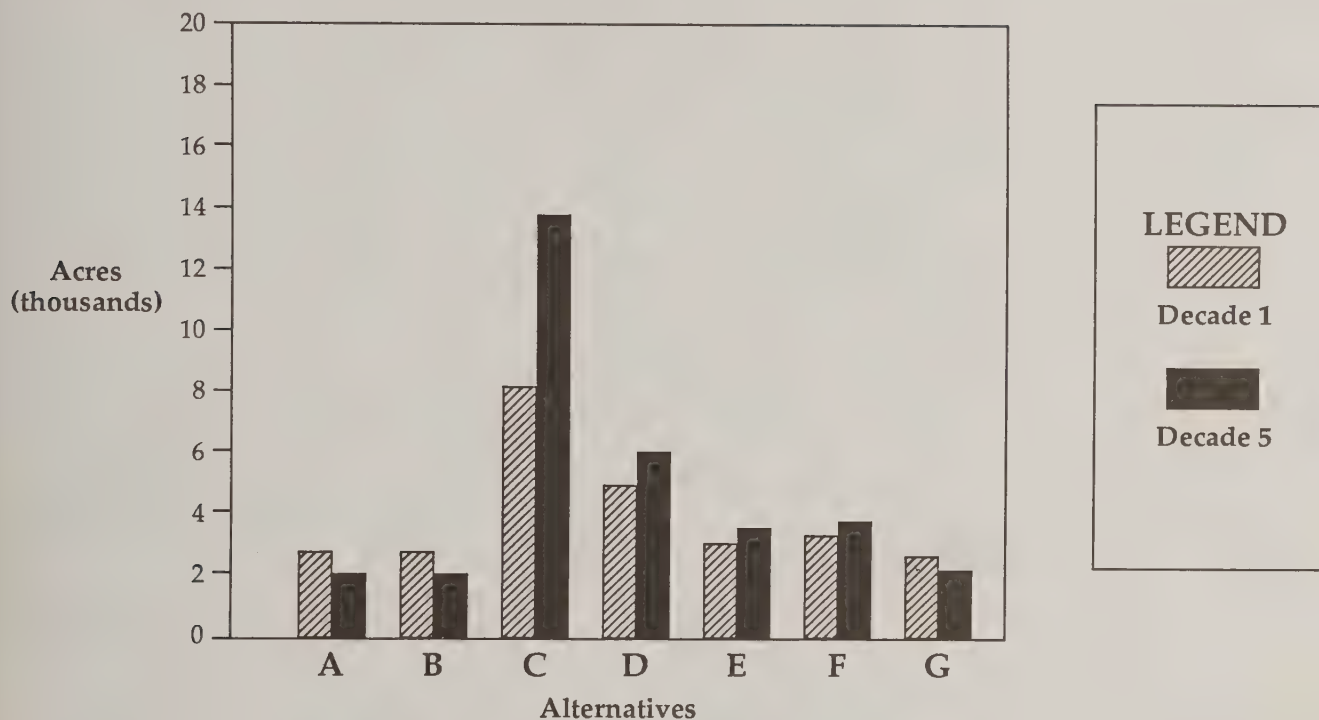


Figure IV-4

Expected Acres Burned by Wildfire / West-side

Prescribed burning to manage competing and unwanted vegetation does have the potential to damage air quality in the Pacific Northwest Region. Other vegetation management methods may have minor, temporary impacts on air quality. This discussion of air quality impacts specifically focuses on the use of prescribed fire.

The criteria used in assessing the effects of prescribed burning on air quality are as follows:

- 1) Attainment and maintenance of air quality, including National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD).
- 2) Protection of visibility in Class I areas.
- 3) Consistency with respect to air quality and visibility control strategies.
- 4) Consistency with respect to Federal and state environmental policies.
- 5) Public health protection.

A total suspended particulate (TSP) emission source inventory from prescribed burning in western Oregon and Washington was compiled for the baseline period 1976 through 1979, and separately for 1984 (Sandberg et al. 1985). In 1984, total suspended particulate emissions from prescribed burning in western Washington and Oregon were 28

Air Quality

percent less than during the 1976-79 baseline period (Sandberg 1986).

The same kinds of baseline emissions information can not be developed for either eastern Oregon or Washington. Prescribed burning in those areas is not regulated under the Smoke Management Plans of the two states, hence the information about actual acres treated, fuel loadings, etc. can only be estimated, and are not of the quality required for the analysis.

Our analysis of the effects of prescribed burning compares projected burning under the various EIS alternatives in the year 2000. The year 2000 is used to be consistent with Oregon's emission target—a 50 percent reduction by 2000.

Each Forest in the Region was asked to estimate—by vegetation type and EIS alternative—the amount of burning that would take place in 2000; the time of year burning would occur; anticipated fuel loadings; and burning technique (underburning, pile, or broadcast burning). Each Forest was also asked to provide the same information for their current (1986-87) burning program.

The data supplied by the Forests were analyzed using emission estimation methods developed by the Forest Fire and Atmospheric Sciences Research Team of the Pacific Northwest Research Station.

Note that the analysis is for particulates less than 2.5 microns in diameter (PM-2.5) rather than total suspended particulates (TSP). The smaller particulates are of most concern, since that is the fraction most responsible for the concern about the effects of smoke on human health and visibility.

Projected Prescribed Fire Emissions

Pacific Northwest Region: Total emissions for the Region, for all alternatives, will decline at least 37 percent by the year 2000, compared to the present, and more than 65 percent from the 1976-79 base period. The decrease is due, principally, to a decline in acres burned (Fig. IV-5), and a reduction in biomass consumption per acre (Fig. IV-6).

The reduction in biomass consumption will come about through increased utilization, a shift from old-growth to second-growth forest management, and burning at higher fuel moistures.

Western Oregon: Fine particulate emissions for all alternatives will decline at least 33 percent by the year 2000, compared to the present (Fig. IV-7). Acres burned will decline at least 18 percent, compared to the present (Fig. IV-5); and the biomass consumption will decline by at least 17 percent (Fig. IV-6).

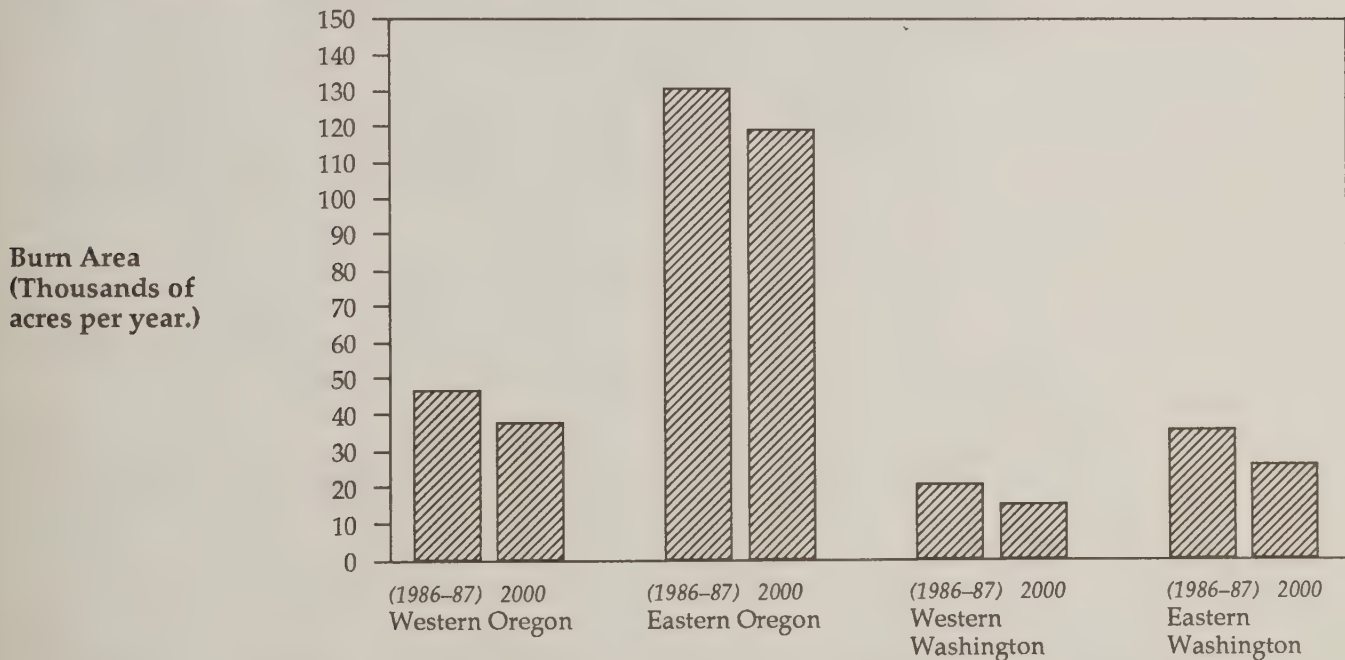
Eastern Oregon: Fine particulate emissions for all alternatives will decline at least 23 percent by the year 2000, compared to the present (Fig. IV-8). Acres burned will decline at least eight percent (Fig. IV-5). Biomass consumption will decline by at least 23 percent (Fig. IV-6).

Western Washington: Fine particulate emissions for all alternatives will decline at least 33 percent by the year 2000 as compared to the present (Fig. IV-9). Acres burned will decline at least 24 percent (Fig. IV-5). Biomass consumption will decline by at least 10 percent (Fig. IV-6).

Eastern Washington: Fine particulate emissions for all alternatives will decline at least 49 percent by the year 2000 as compared to the present (Fig. IV-10). Acres burned will decline at least 23 percent (Fig. IV-5). Biomass consumption will decline by at least 27 percent (Fig. IV-6).

Figure IV-5

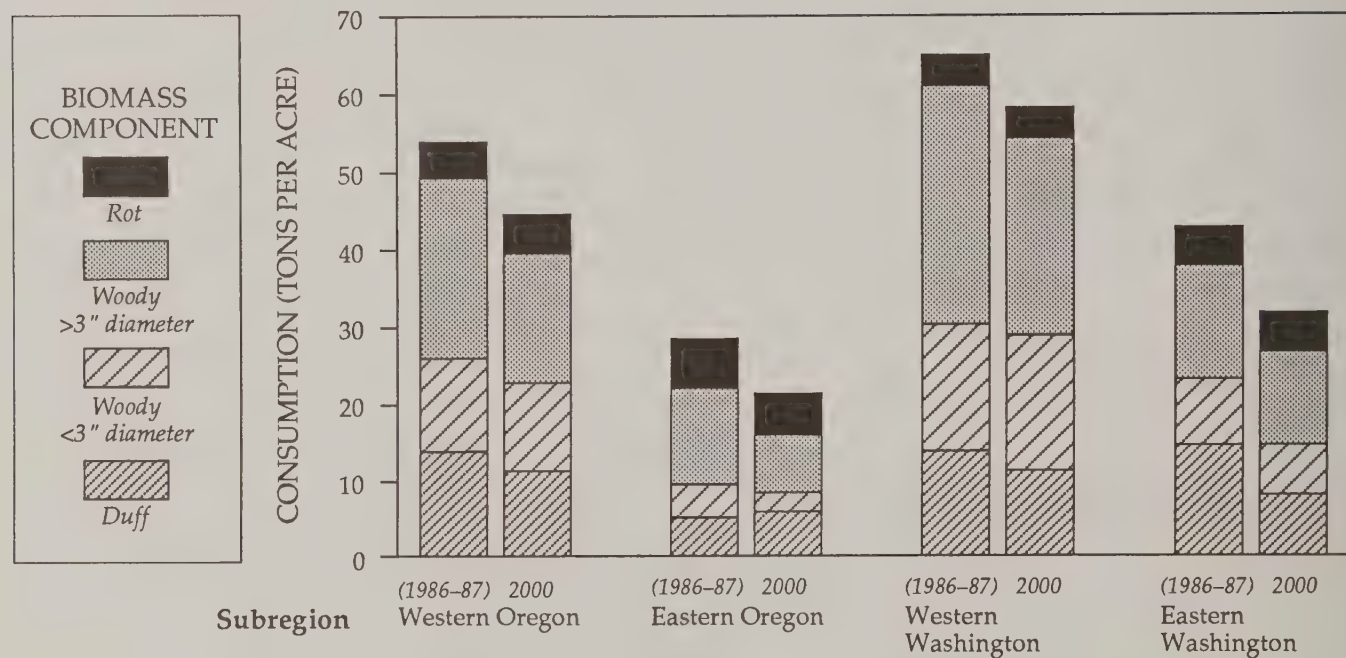
Area of Prescribed Burn by Subregion



NOTE: Over the entire Region, there will be at least a 12 percent reduction.

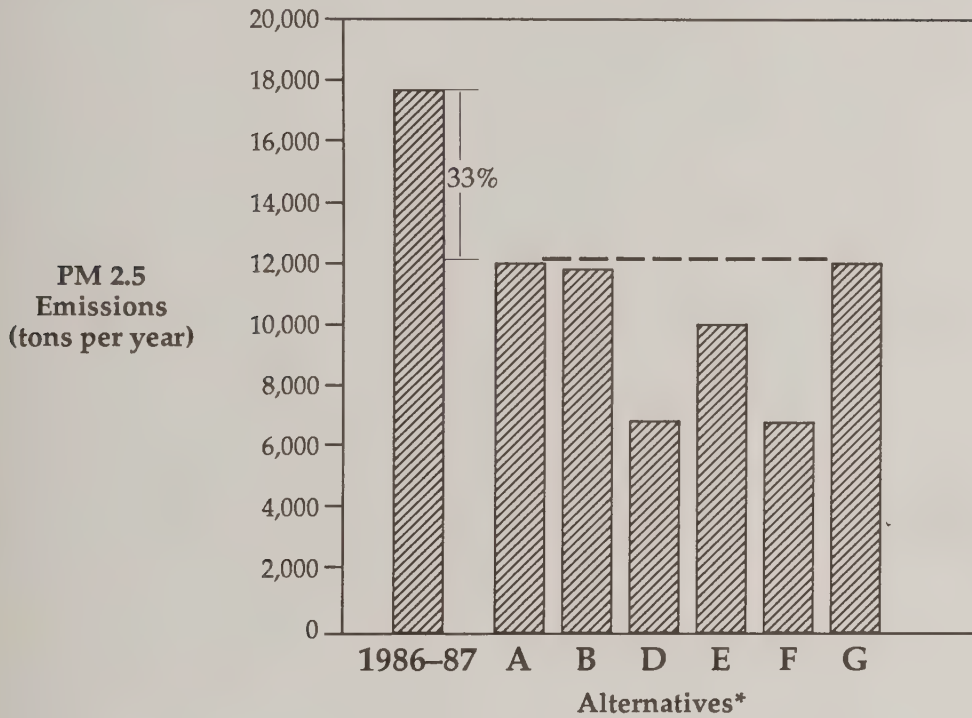
Figure IV-6

Biomass Consumed per Acre by Subregion



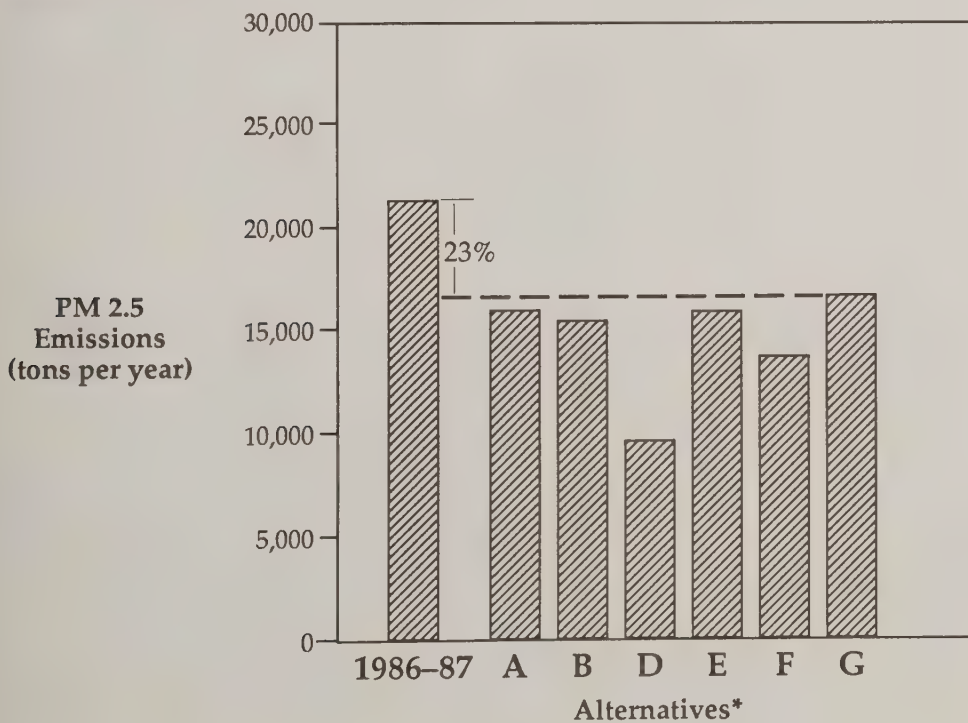
NOTE: Over the entire Region, there will be at least a 12 percent reduction.

Figure IV-7

**Fine Particulate (PM 2.5) Emissions, by Alternative
Western Oregon**

*Alternative C does not allow use of fire for managing competing and unwanted vegetation.

Figure IV-8

**Fine Particulate (PM 2.5) Emissions, by Alternative
Eastern Oregon**

*Alternative C does not allow use of fire for managing competing and unwanted vegetation.

Figure IV-9

Fine Particulate (PM 2.5) Emissions, by Alternative Western Washington

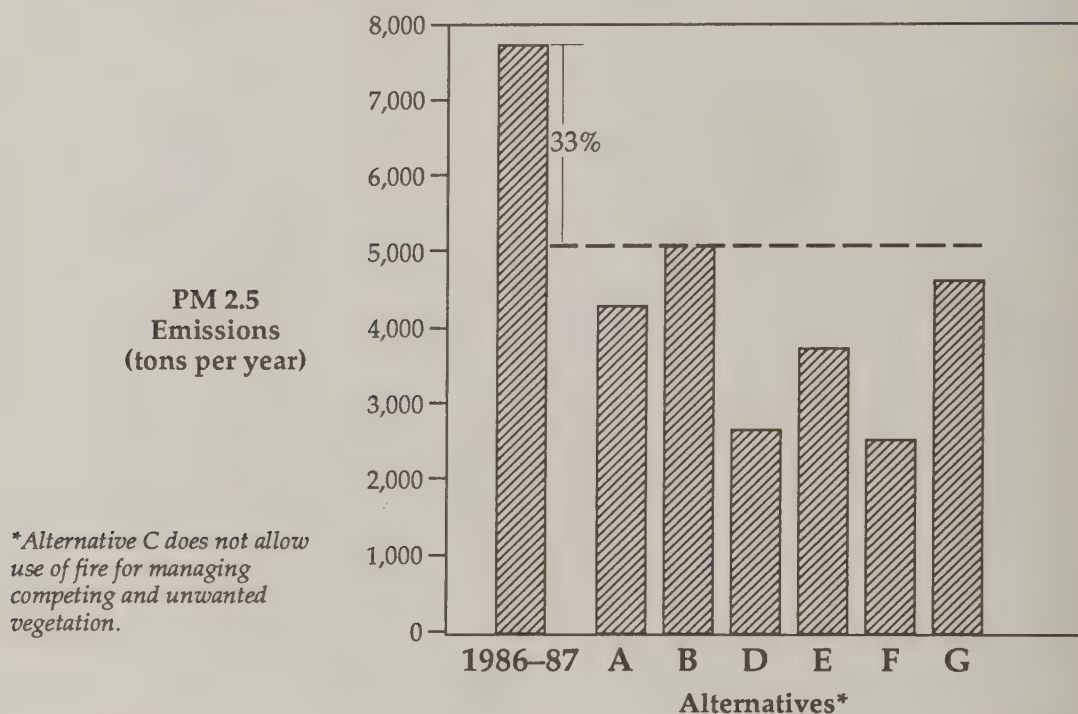
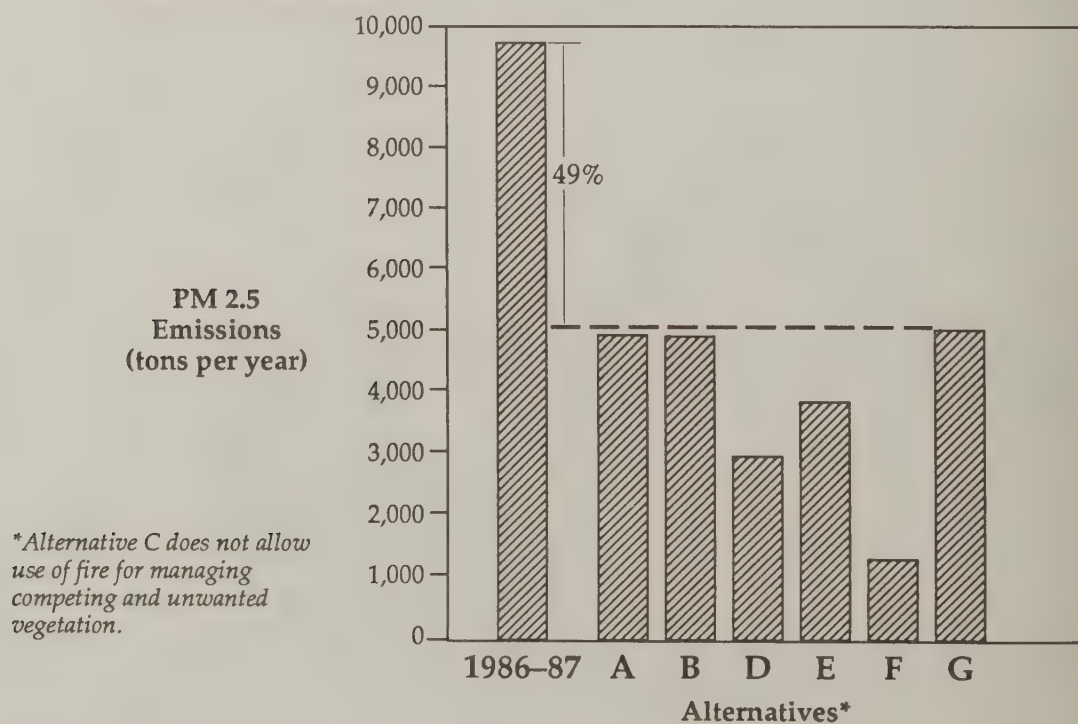


Figure IV-10

Fine Particulate (PM 2.5) Emissions, by Alternative Eastern Washington



Smoke from wildfires will also have an impact on air quality in the Region. Wildfires consume about three times as much fuel as prescribed fires for the same area burned, and may produce about ten times as much fine particulate matter (Ward et al. 1976).

Wildfires, unlike prescribed fires, cannot be planned for periods when environmental conditions are conducive to minimizing emissions. Prescribed fires mainly consume smaller, readily ignited fuels, and are more completely and efficiently burned (Cooper 1976). Wildfire severity is generally greater than prescribed fire severity. Consequently, more of the larger fuels are burned, and combustion efficiency is lower.

Many managers believe that prescribed burning reduces the number of acres burned by wildfire. Cramer (1974) attributed the reduced amount of acres burned by wildfire in the southern United States to increased use of prescribed fire. In the Pacific Northwest, fuel hazard abatement, coupled with increased efficiency in fire suppression have reduced the number of acres burned by wildfire (Tiedemann 1978).

Statistics compiled by the Washington Department of Natural Resources (DNR) for the years 1973-1977 indicate that 44 percent of wildfires occurring on DNR-protected lands, statewide, started in untreated logging and thinning slash. An additional 20 percent of the wildfires spread further by burning through untreated slash. One fire was stopped and controlled at the point it encountered an area that had been previously prescribed burned (Geomet, Inc. 1978).

Table IV-12 and Figures IV-2, IV-3, and IV-4 show that, for all alternatives except G, an increase in prescribed fire use decreases the expected acres burned by wildfire. Conversely, a decrease in prescribed fire use increases the number of acres expected to be burned by wildfire. Thus, there is a definite trade-off between degradation of air quality by wildfire smoke or by prescribed fire smoke.

Table IV-12

Wildfire and Prescribed Fire: Expected Area Burned (Thousands of Acres) Per Year

(First and second decades following implementation of an alternative.)

Alternative	A	B	C	D	E	F	G
<i>Source</i>							
Wildfire*							
Decade 1	15.7	15.7	25.0	20.7	16.0	18.1	16.5
Decade 2	13.0	13.0	41.0	25.0	14.5	22.0	13.7
Prescribed Fire	21.6	22	0	13.5	20.3	12.3	23.5

*Average loss (1977-1986) was 21,000 acres each year.

Wildfire Emissions

Attainment/ Maintenance Air Quality Standards

National ambient air quality standards have been developed for carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, ozone, and total suspended particulate (TSP) matter. Attainment areas meet Federal ambient air quality standards; nonattainment areas do not.

Particulate emissions from prescribed burning are expected to decrease below current levels throughout the Region. Therefore, air quality in attainment areas will either be maintained or improved.

All of the nonattainment areas for total suspended particulates—except Clarkston, Washington—are classified in the Oregon and Washington Smoke Management Plans as designated areas. The plans stipulate the conditions under which burning may be conducted near designated areas. Burning is not conducted when smoke will be carried into designated areas. Additionally, prescribed fire emissions on the National Forest adjacent to Clarkston are expected to decline below current levels. Therefore, prescribed burning under any of the EIS alternatives will not degrade the air quality of those areas.

Part C of the Clean Air Act—Prevention of Significant Deterioration (PSD)—requires that increases of contaminants will not exceed the limits set by Congress for Class I, II, and III areas. The increments are relative to air quality conditions that existed in the Class I areas during a baseline period. A PSD emissions baseline was established in 1977-1978 for western Oregon and Washington, however, as noted previously, there is none for eastern Oregon and Washington.

West of the Cascades, emissions from prescribed burning have decreased from the amount emitted during the 1976-1979 baseline period. The trend will continue under all of the EIS alternatives.

Burning east of the Cascades under all of the EIS alternatives will be conducted to avoid incursions of emissions into populated and Class I areas. The best available technology will be used to minimize smoke emissions.

Visibility Protection of Class I Areas

The Pacific Northwest Region is responsible for protecting visibility, an air quality-related value, in areas designated as Class I by the Clean Air Act. All prescribed burning within the Region will comply with the requirements of the Visibility Protection Plans of Oregon and Washington.

The plans outline short- and long-term control strategies for achieving national visibility goals. The short-term strategies are directed at remedying visibility impairment during the high-use period, July 4 through Labor Day. The long-term strategies are aimed at making reasonable progress toward the national visibility goal with specific emission reduction goals.

The short-term strategies severely restrict prescribed burning during the peak summer recreation period (July 4 through Labor Day).

All Forest Service prescribed burning will be planned to comply with the scheduling restrictions.

Oregon's long-term strategies include goals for emission reductions. The Oregon plan requires to a 22 percent reduction over 1984 levels (a 50 percent reduction from 1976-79 levels) in western Oregon annual prescribed burning emissions by the year 2000. The Washington plan sets the objective of reducing total emissions generated by prescribed burning in western Washington by 35 percent of the 1976-79 level.

In the year 2000, the aggregated emissions from western Oregon National Forests will be at least 33 percent less than the 1984 level, and 61 percent less than the 1976-79 level.

In western Washington, all alternatives for each Forest would meet the 35 percent total suspended particulates reduction target by 1990. As of 1984, a 30 percent reduction in emissions had been achieved (Sandberg et al. 1985). An additional 33 percent reduction in emissions will be achieved by the year 2000 under all alternatives bringing the minimum possible reduction to 63 percent of the 1976-79 level.

Visibility impairment has not been identified as a problem in Class I areas east of the Cascades. Therefore, the State Implementation Plans do not include total suspended particulates reduction targets nor burning rules and restrictions for the East-side Forests. In eastern Oregon and Washington, total suspended particulates emissions from prescribed fires will decrease under all alternatives, hence visibility cannot be adversely impacted by any of the alternatives proposed in this EIS.

All of the EIS alternatives are consistent with state air quality and protection visibility strategies. All prescribed burning conducted under any alternative will be conducted in compliance with visibility protection guides and the broader smoke management plans of Oregon and Washington.

Forest Service Manual 2403-1, Region 6 Supplement 347, March 1985, states that prescribed burning will be used only for those units where other alternative treatments are unacceptable. All alternatives will comply with this direction. An analysis will be conducted on a site-specific basis for each project to determine the suitability of other methods. Alternatives will usually be in compliance with state environmental policies and their exceptions.

The principal emissions produced by the open burning of woody fuels are carbon monoxide, particulates, nitrogen oxides, and hydrocarbons.

**Consistency with
Air Quality and
Visibility
Protection
Strategies**

**Consistency With
Federal and State
Environmental
Policies**

**Public Health
Protection**

Particulates are the principal air contaminant problem (Tiedemann 1978).

The effect of particulate matter on human health is a function of size, sorption, and chemical composition of the particles. Inhalable particulates (smaller than 10 but larger than 2.5 microns in diameter) are deposited in the upper respiratory system and may be expelled. Respirable particulates (less than about 2.5 microns in diameter) are generally deposited in the pulmonary tract.

Over 90 percent of the mass of particulate matter produced by prescribed fires is inhalable and respirable (Prescribed Fire and Fire Effects Working Team 1985).

Determining the effects of particulates on human health is complicated by the presence of other pollutants, particularly sulfur dioxide (Coleman 1976). Forest fires emit only trace amounts of sulfur oxides. Therefore, the interaction of particulates and sulfur dioxide should be a health hazard only in areas with a high ambient level of sulfur dioxide.

The other principal emissions from fires that have a potential for direct effects on human health are carbon monoxide, nitrogen oxides and hydrocarbons. Carbon monoxide is very toxic; however, levels are generally diluted to levels which are less than hazardous within a very short distance from the fire (Tangren et al. 1976). Workers exposed to smoke for prolonged periods on firelines are most at risk (Countryman 1971). Very little hazard exists for the public, however (Dieterich 1971). The long-term effect from carbon monoxide is its importance in atmospheric reactions that create photochemical smog (Dieterich 1971).

Information on the effects of nitrogen oxides on human health is scanty (Tiedemann 1978). Tangren and others (1976) suggest that the importance of nitrogen oxides, if there is a connection to human health, probably lies in the formation of secondary products.

Fires also generate numerous hydrocarbon compounds. These compounds may react with sunlight to form photochemical smog (Darley and others 1966). Some of the hydrocarbon compounds produced by fires have been found to be carcinogenic (Hart 1984). Dieterich (1971) expressed concern for the largely unknown synergistic effects of combining two or more chemicals. The resultant compounds may be more toxic to humans, animals, and plants than any of the individual compounds.

Inhalation of smoke can cause acute or chronic damage to health. The effects of smoke on health are dependent upon duration of exposure and concentration levels. Exposure to high levels for short durations can produce effects ranging from irritation of the eyes and respiratory tract to impaired judgment, semiconsciousness, uncon-

sciousness, or even death (Breysse 1984). Repeated exposures to relatively low concentrations may result in respiratory allergies, bronchitis, emphysema, and cancer (Breysse 1984).

Sorption of toxic materials by smoke particles, coupled with the small size of the particles, is conducive to depositing toxic materials deep in the lungs (Tangren et al. 1976).

Compounds such as ketones, aldehydes, acids, polyaromatic hydrocarbons, and alcohols that are produced by a fire can be transported long distances once bound to particulate matter. The toxic compounds are active much longer when bound to particulate matter. However, the compounds are considered to be health hazards only under conditions of long exposure to relatively high levels (Geomet, Inc. 1978). The concentration of toxic compounds downwind of the fire is probably too low to cause measurable health effects (Geomet, Inc. 1978).

Rural dwellers will probably be exposed to more risk from prescribed fire emissions than urban dwellers due to the requirements of dispersing smoke from high population centers. For a more complete discussion of these effects, see Chapter IV, Effects on Public Health.

Water Resources

Manual clearing, chopping, and weeding have a low potential for adverse impacts on water resources. Proper sanitation and precautions to prevent oil and fuel from power tools from entering streams will prevent adverse impacts on water resources from these methods.

Potential Direct and Indirect Effects. Increased sedimentation may result from mechanical methods of vegetation management, depending on operating practices, slope steepness, and distance to the stream channel.

Discussion. First-order stream channels (the upper reaches of a stream, where the channel begins) are most likely to be affected by mechanical piling of slash, scarification, etc., since these channels are small and often located within the treatment area. In order to protect channel stability, slash will not be piled within the high water mark of stream channels. Operation of equipment within stream channels is not necessary for vegetation management.

Operating practices designed to prevent adverse impacts on soils will also prevent impacts on water quality. These practices include timing restrictions; avoiding sensitive soils (especially in municipal watersheds); and limiting equipment to slopes of less than 35

Manual Methods

Mechanical Methods

percent. Protective buffer strips will be left along streams, lakes, and wetlands to act as a filter mat to minimize sedimentation from off the site due to upslope soil disturbance (see Chapter II, Mechanical Methods, Mitigation Measures).

Conclusion. While there is a potential for adverse impacts on water quality, most impacts can be avoided by implementation of the mitigation measures. All alternatives involve use of mechanical methods of vegetation management. Alternatives C and D, respectively, would treat 78 and 35 percent fewer acres using mechanical methods, compared to Alternative B (see Table IV-3, soils discussion, this chapter). These alternatives would pose a lower risk of sedimentation from mechanical methods than Alternatives A, B, E, F, and G.

Prescribed Burning

Potential Direct and Indirect Effects. Possible impacts from burning, if it is severe enough to produce unwettable (hydrophobic) soils, include increased sedimentation, increased nutrients leached from ashes, and increased runoff during storm events. For more information, see the soils discussion in this chapter.

Discussion. The highest potential for accelerated sedimentation is where a small, first-order stream runs through a treatment area. Eroding soil can collect in the small stream and be routed to larger, fish-bearing streams.

Practices that protect the soil resource will also prevent adverse effects on water quality and quantity. An unburned buffer of vegetation along Class I, II, and III (perennial) streams will provide a filter to prevent excessive sediment from entering streams. It also will protect riparian vegetation, which provides shade and bank stabilization. Methods to reduce the severity of prescribed burning will also be utilized to reduce damage to soil and resulting erosion (see the section in Chapter II on mitigation measures for prescribed burning).

Conclusion. Prescribed burning generally does not affect water yield, erosion, or water quality during storm runoff, except where severe fire causes unwettable soils and leads to accelerated erosion (Douglass 1981), or in cases where prescribed fires escape. All alternatives include practices to prevent severe prescribed burns or escaped fires that can lead to this condition.

Alternative C prohibits the use of fire as a vegetation management tool. However, the increased numbers of wildfires expected under this alternative could burn riparian areas or entire watersheds (See Fire discussion, this chapter). Detrimental effects on water quality could result from such fires.

Alternatives D and F significantly reduce (40 and 15 percent, respectively) the number of acres treated with prescribed fire, compared to Alternatives A, B, E, and G (see Table IV-4 in the discussion of

effects on soil in this chapter). However, with implementation of the mitigation measures, none of the alternatives are expected to cause adverse effects on water quality due to prescribed burning.

Potential Direct and Indirect Effects. Livestock grazing may lead to increased sedimentation or increased fecal bacteria, which can create unsafe drinking water. If riparian areas are overgrazed, increased stream temperatures and channel instability may result. Peterson (1983) found that sheep grazing on clearcut units on the Siuslaw National Forest led to a significant increase in fecal coliform concentrations downstream.

Direction found in Forest Service Manuals 2200 (Range Management) and 2500 (Watershed Management), and in individual Forest land management planning documents, is designed to minimize the adverse impacts of livestock grazing on water quality and channel stability. Impacts on downstream domestic water users must be analyzed in project-level planning.

Other biological methods, such as seeding of desired species, will serve to prevent soil erosion and have a beneficial effect on water quality.

Conclusion. The use of biological methods of vegetation management, as implemented under any alternative, is not expected to result in adverse effects on water quality.

Potential Direct and Indirect Effects. Use of herbicides may result in contamination of surface water. All alternatives involving use of herbicides require unsprayed buffers of vegetation to be left adjacent to live streams, lakes, and wetlands (see Chapter II, Herbicides, Mitigation Measures). Therefore, effects on stream temperature and channel stability due to loss of riparian vegetation are not expected.

Discussion. Once in the environment, a chemical herbicide is subject to degradation by soil microorganisms; chemical- and photo-degradation; adsorption onto soil particles and organic matter; volatilization from soil, plant, or water surfaces; or uptake by plants (EPA 1980).

For a herbicide to reach surface or groundwater, it must be relatively soluble in water; resistant to adsorption by soil and organic matter; and sufficiently persistent to endure until it enters the water (Newton and Norgren 1977). Table IV-10 displays the persistence, adsorption, and solubility characteristics of the 16 herbicides, and provides a rating of relative susceptibility to water transport based on these characteristics.

Of the various techniques for herbicide application, aerial application presents the highest hazard for surface water contamina-

Biological Methods

Herbicides

4 Environmental Consequences

tion. Direct application and drift are the principal routes for herbicides to reach surface waters (Norris et al. 1983). Herbicides could reach relatively high concentrations for a short duration through direct application or drift.

The use of herbicides may result in contamination of nearby surface water. Thus, monitoring of water quality is an important component of any herbicide application program.



Wet, marshy areas generally receive higher levels of herbicides for longer periods of time than upland areas, as a slight rise in the water table can flush large quantities into stream systems (Norris 1980).

Mitigation measures to prevent direct application and drift include methods to generate the optimum droplet size to reduce drift; restrictions on environmental conditions which would increase drift; and careful demarcation of unsprayed buffer strips on all live streams, lakes, and wetlands (see Chapter II, Herbicides, Mitigation Measures).

The actual concentration in surface water from direct application depends on the rate of application, depth of water, and interception by overhanging vegetation. For example, if four pounds of active ingredient per acre were applied to a 2-foot deep stream with no overhanging vegetation, the instantaneous peak concentration in the stream would be 736 ppb (parts per billion). However, implementation of the mitigation measures would prevent this situation.

Drift of chemicals is the more likely means of entry into surface waters. Application factors such as nozzle type, emulsion, wind speed, temperature, and relative humidity affect the occurrence of drift.

Contamination by drift can be diminished by buffers of vegetation.

A 100-foot buffer, as required for Class I, II, and III streams (see Chapter II, Herbicides, Mitigation Measures), would result in less than 2 percent of the concentration which would reach the ground beneath

the flight path of a helicopter applying herbicides at a high volume in a 1-10 mph crosswind (Gravelle 1976, in Newton and Norgren 1977). This would amount to 15 ppb in a 2 foot deep stream when the chemical is applied at 4 pounds per acre.

A 200-foot buffer, as required on all lakes and wetlands, would result in less than 1 percent (of the direct overflight concentration) reaching these areas.

As the peak concentration travels downstream, it would diminish due to dispersion, chemical degradation, and adsorption of chemicals to sediments and organic matter (Lorz et al. 1979).

Dilution by tributaries will also reduce the concentration. For example, if streamflow within the 100-foot buffer is 2 cubic feet per second, and downstream at a water intake the flow is 10 cubic feet per second, then the peak concentration would be reduced from 15 ppb to 3 ppb at the intake.

For methods other than aerial application, such as a truck-mounted sprayer used for roadside spraying, chemical application is prohibited within 50 feet of surface water (see Chapter II, Herbicides, Mitigation Measures). Drift from truck-mounted and backpack sprayers can be controlled more closely than aerial application.

Mobilization of herbicides in ephemeral stream channels can be an important mechanism for chemicals to enter surface waters if precipitation prior to chemical degradation is sufficient to cause streamflow. This can result in relatively low concentrations for longer durations (Norris et al. 1983).

Project-level analyses will consider the potential for mobilization of herbicide residues in dry stream channels when determining appropriate treatment of the streamside area along dry, Class IV channels.

Overland flow is rare in the forest environment (Harr 1976). The bare, compacted soils where it does occur are unlikely to be treated with chemicals (Norris et al. 1983). Where runoff does occur, the concentration of herbicide may decrease as it flows over the unsprayed areas adjacent to stream channels (Norris 1981). Nearly all chemicals are applied from March through October, whereas surface erosion events are most frequently associated with intense winter storms in late November through February. It is therefore unlikely that significant movement of chemicals due to erosion (Rice et al., in Norris et al. 1983) or surface runoff will occur.

Leaching of herbicide residues depends on soil type, organic matter content, herbicide solubility in water, rainfall, and chemical persistence. Most herbicides are relatively immobile in soils and do not persist long enough to travel more than a short distance through the soil (Norris et al. 1983).

The width of the untreated buffers makes it unlikely that chemicals would reach surface waters through subsurface flow. However, there are some unknown factors influencing the possibility of groundwater contamination. For example, herbicides may persist in anaerobic conditions found below the water table, where soil microorganisms are no longer present to assist in degradation (EPA 1986).

Groundwater contamination is more likely in areas of high water table, or at tree nurseries (not covered in this EIS) where frequent applications could occur. The low frequency of herbicide application and absence of static groundwater under most forest areas makes the hazard of groundwater contamination low. However, groundwater monitoring will be conducted if a site-specific analysis indicates potential for contamination of an aquifer used as a domestic water supply (see Chapter II, Herbicides, Mitigation Measures).

Once in the aquatic environment, herbicides are lost through volatilization, adsorption on stream sediments, adsorption by aquatic biota, degradation by chemical, biological, or photochemical means, or downstream movement (Newton and Norgren 1977).

In six years of project water monitoring, phenoxy herbicides never exceeded 0.1 milligram per liter (1 mg/L, equivalent to 1,000 parts per billion (ppb)) in western Oregon streams (Norris 1981). In water sampling conducted in 1980-83 on the Rogue River, Umpqua, Gifford Pinchot, Willamette, and Siskiyou National Forests, 235 samples were analyzed. No residues were detected in 203 of the samples; 26 had 0-5 ppb; 4 had 6-11 ppb; 1 had 52 ppb; and 1 had 190 ppb. Table IV-13, next page, displays monitoring results reported in the literature for the most commonly used herbicides in situations which most closely resemble forest usage.

By comparison, the following criteria have been developed for potable and irrigation water. These criteria are expressed as the mean concentration that would occur over a 24-hour period, while the previous table reported instantaneous maximum concentrations. These criteria would commonly be applied to points of use far downstream from treatment units. (See Table IV-9 in the Soils discussion.)

Accidental spills are another possible route of herbicide entry into surface waters. Mitigation measures requiring location of mixing areas away from surface waters; use of equipment which will not leak; and a Spill Incident Response Plan (updated annually) for prompt response if an accident occurs, should minimize the potential for spillage entering water.

Of 17 documented herbicide spills in the Region from April, 1973 to April, 1983, three involved entry into water. Two spills involved helicopters and entry of 50-100 gallons into small streams. One involved a truck and entry of 170 gallons into a drainage ditch.

Table IV-13

Maximum Concentrations of Herbicides Reported Under Conditions Found In the Pacific Northwest

<i>Herbicide</i>	<i>Maximum Concentration</i> (parts per million)	<i>Duration of Detectable Residue</i>	<i>Situation</i>
2,4-D	0.132	1 week	live stream, no buffer (1)
2,4-D	.025	1 week	live stream downstream of spray area (1)
2,4-D	0.84	7 ppb after 12 days	flat, marshy area (1)
2,4-D	.071	54 hours	stream flowing through spray area (2)
Glyphosate	no detectable residue		dry irrigation canal banks treated 23 weeks prior to flow (3)
Triclopyr	.006		runoff 5 months after spray and 59" rainfall
Atrazine	.030		after heavy rainfall no buffer (5)
Picloram	0.37	2 storms after application	rangeland where riparian vegetation treated (6)

(1) Norris and Moore 1981

(2) Norris 1982

(3) Comes et al. in USDA-FS 1984

(4) Norris et al. 1976 in USDA-FS 1984

(5) Douglas et al. 1969 in Norris et al. 1983

(6) Davis et al. 1968 in Norris et al. 1983

Conclusion. Adherence to the mitigation measures for application of herbicides should prevent contamination of surface waters. Accidental spills or unpredicted weather conditions during or immediately after application could result in herbicides entering surface waters. To evaluate this risk, project-level analyses are required.

Alternatives A and C prohibit use of herbicides. Under Alternative E, herbicides would not be applied aerially. This would substantially reduce the risk of chemical contamination of water. All alternatives involving the use of herbicides for vegetation management are subject to the same mitigation measures governing the application of herbicides, and should therefore have similar potentials for contamination.

tion of water. This risk of contamination may be related to the number of acres treated.

Alternative D allows for limited use of herbicides, with a low risk of water contamination. Increasing numbers of acres are treated under Alternatives E, B, F, and G, with corresponding increases in the risk of herbicides entering surface waters.

Cumulative and Synergistic Effects

Analysis of cumulative effects requires a look at "the big picture." Potential cumulative impacts on water resources must be considered on a watershed basis. Potential cumulative and synergistic effects include increased sedimentation, changes in the quantity and timing of peak flows, and chemical contamination of surface and groundwater.

Discussion. Reductions in evapotranspiration in interception of rain by vegetation may result in increased soil moisture, which can lead to increased mass wasting, erosion, and change in the timing and quantity of runoff.

Timber harvest, however, is the primary factor in the Region affecting these changes in evapotranspiration and interception. Additional reduction in evapotranspiration and interception caused by killing brush species is small and brief (Everest and Harr 1982).

Rangeland vegetation treatments generally do not cause a change in the quantity and timing of flows. Vegetation management for range and wildlife habitat improvement is done to change species composition.

The potential for cumulative buildup of herbicide residues within surface waters due to a variety of vegetation management activities within a watershed is low. Yearly, less than 0.2 percent of National Forest System lands would receive application of herbicides under any of the alternatives. In those alternatives permitting aerial application, less than half of those acres would be aerially sprayed.

Application of herbicides for site preparation, release, road maintenance, etc., could conceivably occur within the same season within a watershed. The mitigation measures designed to prevent entry of herbicides into water apply to all of these activities.

Flowing water rapidly dilutes herbicide concentrations. Fast-moving streams with substantial roughness and a stairstep profile dilute peak concentrations rapidly (Newton and Norgren 1977). The previous table showing monitoring results associated with commonly used herbicides illustrates their short-lived nature in forest and rangeland streams.

There is a potential for buildup of herbicide residues in groundwater where numerous sites (all feeding the same aquifer) are treated. Generally, however, dispersion of activities makes this unlikely. Atrazine, bromacil, dinoseb, and simazine have been detected

in the ground water in several Great Plains and Eastern states. These occurrences have been related to agricultural land applications, which involve a much higher frequency and rate of application than forestry uses (EPA 1986).

Information on the fate of herbicides in groundwater is insufficient to determine the potential for impacts on water quality. Groundwater monitoring will be conducted if there is potential contamination of an aquifer used as a domestic water supply. The potential for impacts on domestic water supplies will be considered in project-level analyses.

Conclusion. Dispersion of activities within a watershed is the key to avoiding substantial cumulative impacts. Vegetation management activities in any of the alternatives in a given year will occur on less than 2 percent of the National Forest lands. However, dispersion of these activities cannot be evaluated at the Regional level. Project-level plans will evaluate dispersion of activities within a watershed.

Activities on lands in other ownership, and the effects of other activities on National Forest lands, such as road construction, timber harvest, and grazing will be considered when planning projects under all of the alternatives.

Project-level analyses will include an analysis of cumulative effects on a watershed. This takes into account other past and present activities in the watershed, and protection of existing uses, such as domestic, municipal, or irrigation water supplies.

All alternatives meet existing Regional direction for protection of water resources. The alternatives will also meet or exceed the requirements of Washington, Oregon, and California Forest Practices Acts. Existing cooperative agreements with other agencies involving formally designated municipal watersheds will not be affected.

Changes in water quality and quantity can affect aquatic ecosystems, livestock, and wildlife, and domestic, industrial, and irrigation users. See the discussions on fisheries and wildlife in this chapter.

4 Environmental Consequences

Chapter 4

Environmental Consequences

- Timber Yields
- Rangeland Vegetation
- Noxious Weeds
- Vegetation Diversity
- Threatened, Endangered, & Sensitive Plants
- Wildlife
- Threatened, Endangered, & Sensitive Animals
- Riparian Resources & Fisheries
- Effects Unique to Herbicide Use
- Land Uses
- Recreation
- Facilities
- Rights-of-Way
- Scenery
- Cultural Resources
- Energy Consumption and Production

Timber Yields

Timber yield effects are directly related to the program effects described in Appendices A (Timber Growth and Yield Effects), C (Herbicide Use and Efficacy), and E (Effects on the Silviculture Program).

Vegetation management for site preparation or conifer release affects the establishment and early growth of regenerated stands. A change in silvicultural regimes—such as elimination or restriction of a vegetation management technique—can have the effect of reducing timber yields achievable from some sites. Eventually, these reductions will lead to adjustments in timber harvest levels.

When these timber growth and yield effects are aggregated on a Forest level, it results in a reduction in long-term sustained yield. This may or may not result in a change in the allowable sale quantity (the timber sale program) within the decade covered by an approved timber management or land management plan.



A change in silvicultural regimes—such as elimination or restriction of a vegetation management technique—can have the effect of reducing timber yields from some sites.

When and how these adjustments in harvest levels will result is based on a number of variables that can only be addressed by individual National Forests. Changes in the amount or effectiveness of silvicultural activities, however, will have real effects on the projected supply of available timber.

In this analysis, these effects will be expressed as the predicted change in long-term sustained yield levels.

Actual harvest level adjustments will be assessed by each individual National Forest. In most situations, only that component of the available land base being managed for full or nearly full potential timber growth and yields would be affected.

On lands programmed for less than maximum timber yields (to emphasize other important resource values and management concerns), effects such as tree stocking reductions, loss of commercial thinning opportunities, and extended stand rotation periods can normally be accommodated while continuing to meet the lower timber output targets.

The relationship of the programmed timber harvest level (allowable sale quantity) under an approved management plan to the potential long-term sustained yield level will normally determine the need for adjustments.

For example, on a Forest where the allowable sale quantity is essentially the same as the potential long-term sustained yield level, a reduction in the long-term sustained yield level could trigger an immediate reduction in the timber sale program. This set of circumstances, however, is not the typical case for most Forests in the Pacific Northwest Region.

Other variables, such as timber management harvest priorities; opportunities for rescheduling between Forests; departures from the nondeclining even-flow policy; or the rate at which growth rates are building toward site potentials can affect the actual allowable sale quantity. For these reasons, a comprehensive Forest-level analysis would be needed to translate per-acre growth and yield effects into Forest-level timber harvest adjustments. Subregional effects are estimated following the discussion of effects for each alternative.

Alternative A The suspension of herbicide use will result in a reduced effectiveness of treatment for some silvicultural prescriptions. This is primarily due to a reduced duration of vegetation control when dealing with target vegetation that has a potential for aggressive site reoccupancy. For example, on the average, Regionwide, it has taken an estimated 1.8 manual cuttings—compared with 1.1 herbicide treatments—to adequately meet prescription release objectives.

THE PREDICTED CHANGE IN LONG-TERM SUSTAINED YIELDS IS ESTIMATED TO BE MINUS 2 TO 3 PERCENT. THIS WOULD REPRESENT APPROXIMATELY 75 TO 125 MILLION BOARD FEET ANNUALLY.

Appendix A (Timber Growth and Yield Analysis) contains a detailed assessment of short-term growth reduction and tree mortality in several major vegetation complexes, following the suspension of herbicide use.

Reduced treatment effectiveness would occur on sites with well-established tanoak and madrone. There will also be a slight reduction of site preparation or conifer release effectiveness in control of ceanothus species and herbaceous vegetation in certain situations.

Yield reductions related to the loss of herbicides would be concentrated in the southern Cascades and Siskiyou Mountains, and a portion of the southern Coastal subregions. There will also be minor impacts on Forests within the Transition and East-side subregions.

Effects on budget levels: The implementation of Alternative A assumes an increased budget allocation for silvicultural activities. This is done to accommodate the cost effect of a shift from herbicide use to alternative methods of site preparation and conifer release.

This reflects the most likely implementation strategy, should Alternative A be selected, and also displays the importance of these activities in the timber management program.

All Forests were asked to assess the impact if budget were held constant, resulting in a reduced silvicultural program of work under Alternative A. Results indicate that an additional 1-1/2 percent reduction in timber yields would eventually occur.

This means that Alternative A under a constrained budget will result in roughly a 3-1/2 to 4-1/2 percent eventual reduction in timber yields—reflecting the reduced effectiveness of treatment in some situations, plus an increased cost-of-doing-business.

This alternative is used as a reference for the evaluation of other alternatives. THEREFORE, THERE WILL BE NO CHANGE IN LONG-TERM SUSTAINED YIELDS.

The anticipated allowable sale quantity from Pacific Northwest Region Forests has been estimated at 3.8 to 4.3 billion board feet per year in the near future, as Forest Land Management Plans are developed and implemented. This figure provides a frame of reference for the magnitude of change between the other alternatives.

All vegetation management tools and techniques are available for use in the appropriate environmental setting under Alternative B. This will eventually translate into a high level of timber yields.

Alternative B

The lack of vegetation management for reforestation will result in severe falldowns in long-term sustained timber yields.

THIS PREDICTED REDUCTION IN LONG-TERM SUSTAINED YIELD IS ESTIMATED TO BE BETWEEN 25 AND 50 PERCENT. THIS REPRESENTS APPROXIMATELY 1,000 TO 2,000 MILLION BOARD FEET ANNUALLY.

Alternative C

Appendix A (Timber Growth and Yield Analysis) contains a detailed analysis of yield effects in six major vegetation complexes. This scheme of management—i.e., reforestation efforts without early control of competing vegetation—may be inconsistent with National Forest Management Act requirements regarding a reasonable assurance of

timely stand regeneration. There would also be major changes in the allocations of timberland designated suitable for management designations on National Forests, due to the high risk of regeneration failures under this alternative.

Alternative D

In the short term, the added caution and reduced tolerance for data gaps and uncertainty will result in lower accomplishment of site preparation and conifer release activities. For example, estimates from the 19 National Forests indicate that 12 percent of the silvicultural diagnosis would result in a no-treatment or deferred action decision under Alternative B. Under Alternative D, however, an estimated 26 percent of these prescriptions would be a deferred or no-action decision. (See Appendix E—Silvicultural Program Effects.) This means that an additional 15,000 acres per year will be left untreated under Alternative D.

THE EVENTUAL EFFECT ON LONG-TERM SUSTAINED TIMBER YIELDS IS ESTIMATED TO BE A 1-1/2 TO 2 PERCENT REDUCTION; OR APPROXIMATELY 55 TO 85 MILLION BOARD FEET PER YEAR.

The Forests indicate that knowledge gained through an increased emphasis on research and monitoring will tend to make vegetation management more effective and efficient in the long term. Management emphasis under this alternative would probably encourage more creativity in the development of problem prevention schemes for site-specific situations.

Alternative E

Aerial herbicide applications are discontinued and manual treatments are more restricted under this alternative. Suspensions or restraints on individual herbicides will also be imposed. The effectiveness of vegetation control for reforestation will be reduced on steep terrain, and on sites occupied by tall or dense competing vegetation.

Assessments made by the 19 Forests indicate that a slight increase in deferred action or no-treatment decisions will occur in comparison with Alternative B (approximately 1,000 acres per year).

THIS IS ESTIMATED TO TRANSLATE INTO A EVENTUAL CHANGE IN LONG-TERM SUSTAINED YIELD OF MINUS 1 TO 1-1/2 PERCENT, OR APPROXIMATELY 35 TO 65 MILLION BOARD FEET PER YEAR.

Alternative F

The loss of prescribed burning as a site preparation method will have negative effects on the success of reforestation efforts in a few situations. Appendix E (Silvicultural Program Effects) contains an analysis of the role of fire in the reforestation program. The principal effect

leading to reduced timber yields is an increase in non-stocked or poorly stocked inclusions within managed stands. Primarily, this would occur where concentrations of brush or logging residues create physical obstructions to planting. Projected timber yields from such stands would be adjusted downward to accommodate the lower tree numbers and poor spatial distribution effect.

BASED ON FOREST ESTIMATES, THE ELIMINATION OF BURNING FOR SITE PREPARATION WILL TRANSLATE INTO A 2-1/2 TO 3 PERCENT REDUCTION IN LONG-TERM SUSTAINED YIELDS, OR APPROXIMATELY 95 TO 125 MILLION BOARD FEET PER YEAR.

Less significant consequences under this alternative would include reduced tree growth and vigor in some newly established stands, and the destruction of standing timber volumes due to increased occurrence of wildfire. Regionwide, this would have limited impacts on future timber yields (see Appendix E), but could cause serious disruptions at the Ranger District or timber compartment level of project planning.

Forests within the Coastal and southern Cascades subregions would be most affected under this alternative.

The enlarged program of work for site preparation and conifer release would eventually translate into an increase of long-term timber yields in some situations (see detail in Appendix E). For example, there is a 12 percent increase in cultural treatments in comparison with the other alternatives.

THE FORESTS ESTIMATE THAT THIS INTENSIFIED MANAGEMENT WILL LEAD TO A 2-1/2 TO 3 PERCENT INCREASE IN LONG-TERM SUSTAINED YIELDS; OR APPROXIMATELY 95 TO 125 MILLION BOARD FEET PER YEAR.

An improved trees-per-acre stocking level in some difficult reforestation conditions is the primary beneficial aspect seen under this alternative. Most of the intensified management efforts would be directed at lands that are considered only marginally suitable for regulated timber harvest. This would often mean that some cost efficiency would be sacrificed, and that the risk of long-term productivity damage on some fragile sites would be somewhat increased. An example of such a situation might be the conversion to regulated timber harvest of some non-commercial hardwood stands growing on sites with skeletal or poorly developed soil profiles in the southern Cascades.

Alternative G

Subregional Timber Yield Effects

The variation in potential long-term sustained yield among the alternatives for the Region as a whole is comparatively small, ranging from a maximum reduction of 4-1/2 percent to a maximum increase of 3 percent (with the exception of Alternative C, the "no action" alternative).

Larger variation will occur from Forest to Forest between the alternatives. Assessing this variation from Forest to Forest is difficult. This is because current land management planning underway on each National Forest considers alternative management strategies. Each of these land management alternatives is associated with a unique long-term sustained yield level.

The potential differences in long-term sustained yield expected from the vegetation management alternatives considered in this EIS are generally (with the exception of Alternative C) very much less than the differences associated with alternatives being considered in each Forest Plan. For the purpose of this EIS, the estimates of local variation in long-term sustained yield are made by disaggregating total Regional variation among the alternatives, and distributing it proportionately to the subregions, as defined below.

	Subregion	National Forests
<i>Washington</i>	Coastal	Olympic
	Western Cascade	Gifford Pinchot, Mt. Baker-Snoqualmie
	Transition	Wenatchee
	Eastside	Okanogan, Colville
<i>Oregon</i>	Coastal	Siuslaw, Siskiyou
	Western Cascade	Rogue River, Willamette, Umpqua, Mt. Hood
	Transition	Deschutes, Winema
	Eastside	Ochoco, Wallowa-Whitman, Umatilla, Malheur, Fremont

The analysis of growth and yield for this EIS (see Appendix A) is comprehensive for the different vegetation complexes assessed for each alternative.

The accuracy of the estimate for Regional variation is sufficient to assess the relative difference among the vegetation management alternatives. While the degree of accuracy for estimates of subregional variations is less, it is still sufficient for assessing the relative difference among alternatives by subregion.

The estimates of changes in yield by subregion were made by disaggregating the variations in yield for the different vegetation complexes. Using this information on a per acre basis—according to

the amount of a given vegetation type in each subregion—these variations in yields were then summed for each subregion.

According to the Forest Plans being prepared, there is a great deal of potential variation in long-term sustained yields for subregions, depending on which Forest Plan alternatives are selected. The subregional variation in timber yield for the alternatives considered in this vegetation management EIS are combined with the changes in long-term sustained yield estimated in Forest Plans. The resulting combination shows a range of potential changes in long-term sustained yield for each alternative for each subregion.

These subregional estimates indicate the relative potential for change among the alternatives being considered in this EIS. They do not represent decisions on the allowable sale quantity, nor do they make decisions about allocation of long-term sustained yield to subregions. Allowable sale quantities and long-term sustained yields are currently being developed on a Forest by Forest basis as part of the land management planning process.

The vegetation management alternative eventually selected for implementation after completion of the Final Environmental Impact Statement (FEIS) may have implications for allowable sale quantities or long-term sustained yields. These implications will be considered on a Forest by Forest basis after the preferred alternative is selected in the FEIS.

Changes (related to the vegetation management alternative selected) in an individual Forest's allowable sale quantity or long-term sustained yield will be made through the land management planning process. These changes (if any) could result in issuance of a Supplement to a Forest's Plan, or reissuance of a Draft Forest Plan.

Table IV-14

Potential Change in Long-Term Sustained Timber Yield*

****MMCF per Year**

Alternative	A	B	C	D	E	F	G
<i>Washington</i>							
<i>Subregion</i>							
Coastal	(None)	(None)	-8.9 to -11.9	-4 to -6	-2 to -6	-1.8 to -2.4	+2 to +3
Western Cascade	-1.1 to -1.9	(None)	-14.7 to -25.8	-7 to -1.3	-4 to -6	-1.5 to -2.6	+1.5 to +2.6
Transition	(None)	(None)	-4.1 to -6.9	-2 to -3	-1 to -2	-4 to -7	+1 to +2
Eastside	(None)	(None)	-9.0 to -15.4	-5 to -8	-2 to -4	-2 to -4	+2 to +4
<i>Oregon</i>							
<i>Subregion</i>							
Coastal	* -6.6 to -8.1	(None)	-40.3 to -49.6	-2.5 to -3.1	-4.0 to -5.0	-4.0 to -5.0	+2.0 to +2.6
Western Cascade	* -6.2 to -8.7	(None)	-82.9 to -115.3	-5.2 to -7.2	-4.1 to -5.8	-8.3 to -11.5	+4.1 to +5.8
Transition	-1.4 to -2.0	(None)	-17.1 to -24.3	-9 to -1.2	-3 to -4	-3 to -4	+2.6 to +3.6
Eastside	-3.3 to -4.7	(None)	-39.2 to -56.2	-2.0 to -2.8	-7 to -9	-2.6 to -3.7	+5.9 to +8.4

*Yield effects will be concentrated on Forests within the southern portion of the subregion.

**An average Region-wide conversion is approximately 5.18 board feet per cubic foot.

Rangeland Vegetation

The vast majority of rangelands are in the East-side subregion. The Transition subregion has a significant amount, but the Cascade and Coastal subregions have few rangeland acres. Most “rangelands” in these latter two subregions are categorized as transitory: they are forage opportunities created by timber harvest. Consequently, range improvement projects are conducted almost entirely on the East-side and Transition subregions.



Range improvement activities are designed to have positive effects on the species composition and amount of forage.

Range improvement activities have the greatest potential to affect rangeland vegetation. Projects are designed to have positive effects on the species composition and amount of forage; thus, there should be no adverse effects on the rangeland vegetation. Effects on the other environmental components, such as water, soil, threatened plants, and diversity are discussed in earlier sections of this chapter.

Approximately two-thirds of the acres treated for range improvement would be treated using herbicides under most alternatives. Prescribed fire is the next preferred method. Biological, mechanical, and manual methods would be used on less than one percent of the acres.

Since the objective of the program is improvement of rangeland vegetation, there should be no adverse effects. Potential adverse effects on rangeland vegetation are associated with the differences in acreage treated by alternative, not method.

Conclusions. The direct effect of treatment is an increase in forage on the grass and shrub/bunchgrass range types. On forest/bunchgrass, shrub/bunchgrass, and transitory range, the effect is an

Methods

increase in the land available for forage production, and an increase in available forage. Indirectly, the amount of forage available affects the number of animals an area can support and the amount of red meat production.

Under Alternatives B, E, F, and G, approximately the same number of acres (16,000) are treated. Under alternative C, A, and D (respectively), 0, 6,000, and 9,000 acres are treated. Thus, some reduction in land and forage availability can be expected (relative to the other alternatives) if Alternatives C, A, or D are selected.

Noxious Weeds

The noxious weed program is designed to prevent the adverse effects of noxious weeds on animals (usually domestic livestock), and to a lesser extent, the human population. Adverse effects can result from allowing noxious weeds to spread. Poisonous species may disable or kill livestock, wildlife, and occasionally people (refer to the program descriptions in Appendix G).

Administration of the program can have effects on the environmental components. Each component is discussed earlier in this chapter. Treatment of noxious weeds is not expected to seriously affect the environmental components because of the small acreage involved (from 4,000 to 10,000 acres in the action alternatives), and because the biological agents (usually insects or their larvae) act only on the target species (they are "species-specific"). Herbicides would be used on about one-quarter of the acreage except in Alternatives A, in which herbicides are not allowed; C, the "no action" alternative; and G, in which herbicides are used two-thirds of the time.

Conclusion. Alternative C, in which no action is taken, would adversely affect the efforts to curb the spread of noxious weeds, and has the potential to result in higher mortality of livestock and a reduction in the amount of utilizable range. It would substantially detract from the efforts of cooperating agencies to control noxious weeds.

Diversity

Diversity is popularly thought of as the number of different species in a defined area. However, more precise definitions often include measures of the relative abundance of each species, and their distribution over time and space. This broader, more precise view could be used to assess population trends and some aspects of animal habitat.

Potential Direct Effects. The potential direct effects of vegetation management on diversity are changes in the amount of plant cover; the number of individuals; the number of different species

(species composition); the age class distribution (the relative number of old and young species and their life span); and the structural characteristics (the height and the distribution of plants).

Of these possible effects, the most sensitive to changes in diversity is the number of different species, or species composition.

Potential Indirect Effects. The most important and immediate indirect effects of change in vegetation are on wildlife (for those effects see the section on wildlife in this chapter).

The potential for effects on long-term site productivity as an indirect result of changes in diversity are not known. More long-term monitoring and research is needed. There is concern that a reduction in brush cover could result in lower carbon input into the soil over time. Another concern is the reduction of cover and shortening of the life cycle of nitrogen-fixing plants.

General requirements for the maintenance of natural diversity are given in the Code of Federal Regulations 36 CFR 219.27 (a), (b), and (g). Although no specific index is given, the intent is to maintain populations of natural plants over the landscape. The standards and guidelines listed in Chapter II in the methods section, and the specific Forest Standards and Guidelines listed in the planning documents will be applied. Thus, potential effects on vegetation diversity are expected to be minimal.

Consistent with regulations and the Standards and Guidelines, most methods of vegetation management are not intended to kill the competition, except in the noxious weed program. The intent is to change the dominance of species to favor of the crop tree (or other preferred) species, by reducing the amount of competing vegetation. Consequently, the most consistent effect on vegetation is a reduction in cover of the target species.

Alternative A has the greatest potential effect on diversity. Approximately 185,000 acres are expected to be treated mechanically, and 218,000 acres treated thermally. Chemicals are not used. Mechanical methods and prescribed fire have the greatest effect on diversity because they are the most difficult to control (see the appendix on efficacy). Plants can be removed with the roots, indiscriminately, by a brush blade when scalping. Broadcast burning is also very non-selective. However, a majority of the acres treated mechanically are on the East-side, where slopes are not steep and treatment can be controlled. Fire does have the potential to enhance diversity by keeping fire-dependent species healthy, however. (See the discussions on fire in Chapters III and IV.)

A relatively high number of acres are treated with fire in Alternatives B and G—210,000 and 215,000, respectively. The effects on

Effects on Diversity

cover and diversity depend on how well local and Regional mitigation measures are followed.

Alternative C treats the lowest total number of acres—the only vegetation management done under this alternative is that needed to provide for public safety. Fire is not used. The potential for adverse effects on diversity directly resulting from vegetation management is reduced. Over the long term, however, the probability of more severe, extensive wildfire is increased (see the section on wildfire in this chapter).

Severe wildfires could potentially have more serious adverse effects on diversity than prescribed fire or mechanical methods of vegetation management.

Potential Cumulative Effects

Plant population numbers could be increasingly reduced if successive activities were too frequent to allow revegetation of plants removed from the site.

Changes in age class distribution can result when the crop trees shorten the age span of shade-intolerant brush by effectively reducing the amount of sunlight reaching the understory.

Conclusions. Since total removal of the plant has the most serious adverse effects on plant diversity, mechanical methods (such as scalping) have the highest potential for adverse effects. Small concentrations of a population may be removed during the most intensive operations. Normally, that is not a serious problem, but the effect on the total population is adverse if the plant is rare, or if the only remaining concentrations are too far removed to reestablish themselves. Locally, diversity will have been reduced. Strict adherence to standards and guidelines and mitigation measures should prevent any adverse effects.

Threatened, Endangered, and Sensitive Plant Species

Discussion. Populations of plants can be adversely impacted through direct site disturbance or indirectly by a shift in the vegetation composition of an area that favors more competitive or invasive species. For these reasons, it is imperative that all project level assessments include surveys to determine the presence of plants listed on the Regional Forester's Sensitive Species List. This list is available for review upon request.

Identification of any threatened, endangered, or sensitive plant species within a project area will be followed by consultation with the

U.S. Fish and Wildlife Service; Oregon Natural Heritage Program; or the Washington Natural Heritage Program. Protocols for proceeding with biological evaluations are specified in Forest Service Manual 2700.

Following these protocols will minimize the potential for any adverse consequences in all alternatives.

Wildlife and Wildlife Habitat

Different vegetation management activities and the techniques employed have varying effects on wildlife and wildlife habitat.

These effects vary according to factors such as the method used; characteristics of the site where the treatment is applied; timing and intensity of treatment; the size and distribution of the treatment areas; and the sensitivity of the plant or wildlife species occurring within the project area.

Each method of vegetation management affects wildlife directly by effects on individual animals (death or displacement), and indirectly through changes in habitat suitability.

Introduction



Different vegetation management activities and the techniques used have varying effects on wildlife populations and habitats. The magnitude of these effects can be determined only by assessing predicted changes at the project site.

Both direct and indirect effects may be important to the extent that they lead to changes in populations of wildlife. Cumulative effects may occur as a result of combining treatments within a project area; repeating treatments while the effects of previous treatments (changes in vegetation, compacted soil, chemical residues) are still present; and treating different areas within the same project area over a period of time.

Individual species, as well as groups of wildlife species, respond differently to vegetation manipulation. Activities that benefit some wildlife are likely to be detrimental to others. For example, a study of small mammal populations at sites treated with herbicides in Oregon (Borreco 1972, in Perry et al. 1985) showed that some species (deer mouse and Towbridge shrew) increased, while others (Oregon vole, jumping mouse, and vagrant shrew) declined. Treatments evaluated in this study shifted vegetation dominance from grasses to shrubs, altering both food sources and cover for the small mammals. With any vegetation management activity, at any site, some wildlife populations will increase while others decline.

The effect and magnitude of these changes on wildlife populations can be determined only by assessing predicted changes at the project site in relationship to the surrounding landscape. For example, a range improvement project converting an area dominated by sagebrush to one dominated by grasses and forbs could increase wildlife diversity in a landscape of extensive sagebrush stands. If the treatment area contained the only sagebrush in the vicinity, however, the effect would be to reduce wildlife diversity.

Vegetation management creates opportunities for improving wildlife habitat, as well as creating risks of adverse effects on habitat. The more intensively vegetation is managed, the greater are both risks and opportunities. The risk of adverse impacts of vegetation management on wildlife and wildlife habitat can be minimized by the following means:

- controlling the size and distribution of treatment area (on a drainage or other geographic basis);
- controlling the selectivity of treatment (through choice of method or through the intensity of application) to influence changes in structure and composition of vegetation, and thus of wildlife habitat; or
- controlling the timing of application or treatment to reduce effects on a wildlife species or groups of species. (For example, spring burning is likely to have greater adverse effects on nesting birds than does fall burning, but may lead to greater growth of forage for herbivorous species.)

Determining specific project requirements and mitigation measures will depend on site-specific analysis of potential effects and consequences, and on development of wildlife objectives in coordination with other resource management programs and agencies.

Manual Methods

Potential Direct and Indirect Effects. Manual techniques have the lowest potential for direct effects on wildlife. These techniques have

minimal influence on habitat components other than vegetation, and can be selectively applied. The effects of these methods are therefore limited to indirect or cumulative effects associated with habitat alteration.

Effects can be controlled to manipulate plant species composition, structure, and successional patterns on a project site. These changes may be used to maintain, enhance, or diminish wildlife populations in the area.

Cumulative Effects. A combination of manual treatments within a project area may have cumulative effects related to the distribution and diversity of plant communities and successional stages. This will cause subsequent changes in an area's wildlife populations.

Conclusion. Alternative C uses the highest proportion of manual methods (20 percent) relative to the other techniques available. Alternative A treats the most acres manually, followed by alternatives E, G, F, B, D, and C, respectively. The potential for impact to wildlife populations is proportional to the amount of acres proposed for treatment.

Potential Direct and Indirect Effects. Mechanical methods have the greatest potential for direct effects on soil-dwelling animals such as ground squirrels, pocket gophers and salamanders. When treatments occur in the spring, species such as ground-nesting birds may also be affected. Direct effects are generally limited to the time when activities take place, but may be more long-lasting if soils are compacted.

Down trees and slash provide important habitat for small mammals, reptiles, amphibians, insects, and other invertebrates. Removal of this woody material could result in direct reductions in populations of these species. It could also indirectly affect predator or prey populations through the reduction in food sources. The cumulative effect could be a reduction in wildlife populations over a large area.

For larger wildlife, such as deer and elk, logging slash or natural accumulations of woody debris can impair access, reducing use of an area. Removal or strategic placement of some of this material can improve habitat quality for these animals.

Exposure of mineral soil during mechanical treatments can encourage invasion of plant species adapted to germination on such sites. These species are often undesired brush or tree species (rabbitbrush or red alder, for example). Sites with bare mineral soil have the most risk for invasion by noxious weeds. Growth of these species generally degrades wildlife habitat. Mechanical treatments also provide opportunities to improve wildlife habitat by providing a good seed bed for establishing high-quality grass/legume forage mixes or

Mechanical Methods

preferred browse species.

Conclusion. The greatest potential for important long-term effects of mechanical methods on wildlife populations would result from soil compaction or loss of site productivity. Mitigation measures for mechanical methods (described in Chapter II, and discussed in the soils section in this chapter) will be important in limiting adverse effects on wildlife populations.

Alternatives A, B, E, F, and G would involve similar levels of mechanical methods, and would have similar potential for effects on wildlife. Alternative D would treat 36 percent less area with these methods, with a corresponding reduction in effects. Alternative C would reduce use of mechanical methods by 80 percent.

In general, the fewer acres treated with mechanical methods in a given alternative, the less risk there is to wildlife populations. However, there is a corresponding loss of opportunity to implement post-treatment habitat improvement activities in those alternatives that limit the use of mechanical methods.

Prescribed Burning

Potential Direct and Indirect Effects. Those who have studied the effects of fire on wildlife do not generally consider prescribed fire to pose a serious threat (Lyon and Marzluff 1984; Starkey 1985; and Lyon 1978 in Brown 1985). While there has been relatively little research to evaluate the direct impact of fire on wildlife (Starkey 1985), a number of studies have shown that most species of birds and mammals remain after forest fires (Bendell 1974, in Starkey 1985). Larger and more mobile species can readily flee most fires, and small animals need only retreat a small distance underground in order to survive.

Variations in timing and intensity of fire modify the effects of fire on wildlife habitat. Prescribed burning plans need to provide for protection and maintenance of large fallen logs and snags. These are important habitat components that can be lost through improper control of fire and fire crews. As with mechanical methods, fire can be used to reduce accumulations of slash, improving access for some animals.

Burning can stimulate growth of plants eaten by wildlife, and has been shown to improve palatability of forage for big game (Yoa-kum et al. 1980). Forage improvement activities are highly dependent on prescribed burning for preparation of a seedbed. This is particularly important in areas where soils, topography, or slope limit the use of mechanical methods for preparing a seedbed.

Where fuel accumulations have increased during long periods of fire suppression, animals may not be able to escape or avoid catastrophic fires. Significant numbers of animal kills have been reported for chaparral wildfires in California (Chew et al. 1959, in Starkey 1985).

High intensity wildfires have different effects than most prescribed fires, which typically result in a mosaic of burned and unburned vegetation. These mosaics contribute to habitat diversity. Unburned patches allow maintenance of populations of some species with narrow ecological niches, such as shrews (Starkey 1985).

Conclusion. The effects of fire on invertebrates, which form an important part of the diet for many birds, mammals, reptiles, and amphibians, are not well understood (Komarek 1984). Similarly, little is known about the effects on wildlife populations of by-products of fire such as polynuclear aromatic hydrocarbons, which can cause cancer, and have the potential for accumulating in the bodies of wildlife exposed to them (Perry et al. 1985).

Prescribed burning is used at similar levels in Alternatives A, B, and G. Alternatives E, F, and D would treat fewer acres with fire, and Alternative C would make no use of this method for vegetation management.

The substantially increased potential for catastrophic wildfires in the future that are predicted as a result of implementing Alternative C would increase the potential for direct adverse effects on wildlife populations. Habitat improvement opportunities are highest in the alternatives which increase the use of prescribed fire, and decrease proportionally as use of fire is restricted.

Potential Direct, Indirect, and Cumulative Effects. The use of biological techniques for vegetation management has little potential to directly affect wildlife populations. The potential for indirect and cumulative effects is greater, but varies with the technique used. The primary biological control techniques used are seeding with grass/legume species; controlled livestock grazing; and establishment of insect populations that control the target vegetation species.

Biological Methods

Successful seeding of grasses, legumes, and forbs or planting of shrubs depends on preparation of an adequate seedbed. The most common methods are mechanical site preparation and prescribed burning. The effects of these methods were previously discussed in this section. Seeding is generally used in combination with other "preventive" techniques. Planting of desirable shrub species can be done in combination with manual techniques.

Seeding and Planting

Direct effects to wildlife and wildlife habitat are more closely associated with the site preparation methods previously discussed. Indirect effects to wildlife populations are associated with changes in habitat suitability, and the changes in the quality and quantity of available forage.

Grass/legume seeding increases the quantity and quality of

forage (Sharrow and Rhodes 1983; Sharrow and Leninger 1983). The indirect effect of this technique is a potential increase in carrying capacity and a potential increase in deer and elk reproductive rates (Trainer 19—; Kistner 1983).

On transitory range (conifer plantations), these effects may last 10 to 20 years, depending on conifer stocking levels and site productivity. Grass/legume/forb seeding will increase the length of time that conifer plantations provide suitable habitat for those species dependent on or preferring early seral stages. This is a result of delayed invasion and dominance of a site by shrubs and trees (Klingler 1984).

The potential for indirect or cumulative effects of seeding activities to adversely impact wildlife is low. Generally, wildlife diversity and population levels should increase with seeding activities.

Grazing of Domestic Livestock

Domestic livestock grazing has potential direct, indirect, and cumulative effects on wildlife. The magnitude of these effects depends on the objectives, extent, and control of the grazing activities.

Potential direct effects of livestock grazing must be assessed at the project area level. These potential effects include displacement of resident big game; transfer and spread of parasites and disease; and impacts of predator control measures that may be implemented to protect domestic animals.

Indirect effects that may have impacts on wildlife include changes in habitat suitability; competition for forage on summer and winter range; and displacement from critical habitat (traditional elk calving or deer fawning sites, wallows, water sources, etc.) during specific times of year.

Grazing activities that are properly timed and controlled have potential habitat improvement benefits. These include keeping vegetation in a succulent, highly digestible condition further into the summer; maintaining browse species at heights accessible to wildlife; and improving the quality of forage on winter range. Mitigating measures that minimize the potential impact to wildlife species are listed in Chapter II.

Insects are used to manage vegetation primarily in noxious weed control activities. The release and establishment of insects for biological control has a very low potential to adversely affect wildlife either through direct or indirect means. The insects released for noxious weed control are species-specific. Before insects are released for this purpose, the effects of using them are thoroughly studied and evaluated.

Plants targeted for control are usually toxic to many wildlife species, or compete with preferred forage plants. Wildlife species may, in some cases, actually slow the establishment of biological control

insect populations by utilizing them as a food source.

Conclusion. Alternatives A and D propose the greatest use (most acres) of biological methods. All other alternatives reduce the use of this method; Alternative C proposes the fewest acres of biological treatment.

Potential Direct, Indirect, and Cumulative Effects. In addition to effects on habitat, chemical herbicides have the potential for direct toxic effects on wildlife. Toxic effects can occur as a function of both the inherent toxicity of a substance and the amount of the substance to which an animal is exposed. Wildlife exposure to herbicides can occur from contact, inhalation, or ingestion. Ingestion can also occur through consumption of treated vegetation or other animals.

Cumulative effects may occur when herbicides persist in the environment, contaminated water supplies, or in project areas where multiple treatments are made over a period of time. Highly mobile or migratory species may be most at risk because they can easily move from one treatment area to another. Therefore, these species are more likely to have several exposures within a given year or over a period of years.

For the herbicides under consideration in this EIS, laboratory studies generally indicate relatively low toxicity to wildlife. These herbicides typically do not persist in soil or water (see soil and water sections, this chapter).

Since these chemicals are soluble in water (and not in fat), they do not tend to accumulate in the bodies of animals exposed to them. These factors have led many researchers to reach conclusions similar to those of Morrison and Meslow (198—), who wrote: “The extensive data on toxicity of herbicides to wildlife reveal that both acute and chronic [toxic] doses are well above levels found in the environment under normal field application rates. Furthermore, chronic doses are difficult to realize because of the low persistence of herbicides.”

These views appear consistent with analyses conducted by the Forest Service (USDA Forest Service 1984, 1986) and by the Environmental Protection Agency in development of registration standards. For the herbicides considered here, summary statements in these documents generally indicate at most low toxicity to wildlife.

Quantitative risk analyses have been conducted that estimate the levels of exposure of wild animals to herbicides, and which compare these exposures to levels shown to cause acute toxic effects in laboratory animals (Drug Enforcement Administration 1985, Bureau of Land Management 1987).

These analyses adopt the criteria established by the Environmental Protection Agency (1986), in which potential adverse effects are

Chemical Methods

assumed to exist when estimated exposure levels exceed 1/5 of the LD₅₀ or LC₅₀.

Similar quantitative analyses have been conducted by the EPA to assess risk to threatened and endangered species. For these species, the criteria applied are more stringent. Potential adverse effects are assumed to exist if estimated exposure exceeds 1/10 of the LD₅₀ or LC₅₀.

A review (Serfis et al. 1986) covering pesticides used in forestry applications included 11 of the herbicides considered in this EIS (Amitrol, Atrazine, Dalapon, 2,4-D, 2,4-DP, Fosamine ammonium, Glyphosate, Hexazinone, Picloram, Simazine, and Tebuthiuron). None of these chemicals exceeded the criteria for mammalian or avian species. The toxicity information for the other five herbicides (Asulam, Bromacil, Dicamba, Diuron, Triclopyr), based on similar laboratory studies, is comparable to those covered in the EPA review.

These studies indicate that herbicides being considered in this EIS will not have adverse effects on wildlife populations. However, the limitations of these analyses must be recognized. While nearly 600 vertebrate wildlife species inhabit National Forest lands in the Pacific Northwest Region, laboratory experiments to determine toxicity are conducted with only a few of these species. Inter-species variation in sensitivity to chemical toxicity is considerable. Extrapolation from laboratory animals to "wildlife" involves broad assumptions and considerable risk of error.

Herbicides used to control or eliminate noxious weeds or less palatable species can result in improved forage quality, as long as the residual stand contains a high enough density of grasses to establish the site.

Herbicides used to control grass species, or herbicides that tend not to be selective, may have adverse impacts on available forage within the project area. In the case of aerial conifer release, browse damage from deer, elk, rabbits, hares, and mountain beaver will increase.

The primary reason for this is that herbicide application will not displace these populations from the treatment area, but will reduce the preferred food resources of these species. The conifer seedlings then become a more desirable forage species, relative to the other remaining plants available.

Browse damage risks will be greatest for conifer seedlings less than 30 inches tall during the year of treatment. Resprouting of brush and establishment grasses and annual forbs will increase the forage quantity and quality in following years.

Conclusion. Alternative G will treat the most acres with herbicides, followed by Alternatives F, B, E, and D, respectively. Alternatives A and C do not allow the use of herbicides. The potential for effects to wildlife populations increases as the amount of acres treated increases and as the potential for “corrective” as well as “preventive” treatments increase.

Discussion. As with sensitive plants, project-level biological evaluations and consultation with the appropriate state and federal agencies will minimize the potential for adverse consequences associated with vegetation management. These evaluations include a review of existing recovery plans to determine the compatibility of proposed activities with recovery and/or protection objectives.

Vegetation management activities can benefit sensitive animal species. They are often proposed in recovery plans to improve habitat suitability. The techniques used, timing of the activity, and intensity of treatment will vary by site and species. Thus the direct, indirect, and cumulative effects of these activities must be documented in project-specific biological evaluations.

In summary, no action will be taken in any of the alternatives being considered that would adversely affect the recovery of any threatened or endangered species.

Threatened, Endangered, and Sensitive Animal Species

Riparian Resources and Fisheries

Potential Direct and Indirect Effects. Vegetation management practices that disturb the vegetation, soil, or water of the riparian zone, or cause increased sedimentation (see preceding discussions on soil and water resources) will trigger effects in aquatic systems and fish populations.

These effects may be the result of any method of vegetation management, including manual, mechanical, biological, or prescribed burning. There are possible effects on fisheries resources unique to use of herbicides: these are also discussed in this section.

Increased erosion and sedimentation can inhibit fry emergence (Tagart 1976), reduce fish feeding success, and cause channel aggradation (raising of the bed surface due to deposition). This can lead to loss of pool habitat (Cederholm et al. 1981).

Discussion. While the majority of fish spawning and rearing occurs in second- and third-order streams, the small first-order tributaries are of vital importance to the quality of downstream habitat

(Sedell et al. 1981). These channels carry water, sediment, nutrients, and woody debris from the upper portions of the watershed to the larger streams.

First-order streams are the most vulnerable to impacts from mechanical methods and burning. However, Everest and Harr (1982a) state that broadcast burning and machine piling seldom degrade water quality and fish habitat in small streams, due to the small area involved and the infrequent nature of these activities.

The mitigation measures developed to minimize erosion and sedimentation (see Chapter II) will also be effective in protecting fish habitat. Class IV (intermittent) streams transporting sediment to fish-bearing streams are potential sources of sediment. However, sedimentation due to roads constructed for timber harvest are likely to far outweigh sediment produced by vegetation management activities (Sidle 1980).

Forest Service Manual direction (FSM 2526) and existing Forest land management planning documents call for protection of riparian areas. Vegetation management activities will not occur in riparian areas under any of the alternatives unless specifically prescribed for improvement of habitat.

Conclusion. None of the alternatives will result in substantial adverse effects on the fisheries resource due to alteration of the riparian area, or from increased sedimentation due to vegetation management activities.

Effects Unique to Herbicide Use

Potential Direct and Indirect Effects. The likelihood of exposure of fish populations to toxic concentrations of herbicides used for vegetation management is low. If exposure were to occur, concentrations would be of short duration. The potential for bioaccumulation or bioconcentration of any of the 16 herbicides considered in this EIS is low. A discussion of these two effects follows.

Discussion. For toxic effects to occur in a species, both exposure to a substance and exposure to a toxic concentration of it are needed.

In the forest environment, exposures, if they occur at all, are predominantly short-term acute exposures (Norris et al. 1983). Table IV-10 in the soils section of this chapter shows the relative toxicity of the 16 herbicides considered in this EIS. The table is based on the lowest concentration (reported in the literature) that kills 50 percent of the fish in a 96-hour period (96-hour LC_{50}).

Water quality factors such as temperature, hardness, salinity, oxygen and carbon dioxide content, and pH may affect fish response to herbicides in the laboratory and field (Lorz et al. 1979).

Bioaccumulation is the uptake and temporary storage of a

chemical in animal flesh and organs. Bioconcentration is the increase in the concentration of a chemical within organisms as it moves up through the food chain. Both are most likely to occur when an organism is exposed to a persistent chemical of low water solubility and high lipid solubility. The herbicides reviewed for forest use in this EIS generally do not meet these criteria (Lorz et al. 1979).

The bioconcentration factor is the concentration in the fish divided by the concentration in water. Norris et al. (1983) lists the following bioconcentration factors for commonly used chemicals: 2,4-D, 13; glyphosate, 3; atrazine, 86; picloram, 20. These chemicals are rapidly excreted as the concentration in water decreases (Norris 1980) due to dilution or degradation. By comparison, the bioconcentration factor for DDT is 22,500.

Laboratory studies may not show sublethal toxic effects such as effects on growth; behavior; reproduction; resistance to stress; migration; biochemistry; and physiology. These studies are often conducted on species of fish other than those found in the Region. In general, "cold-water" fish, such as trout and salmon, are more sensitive to herbicides and other pollutants than "warm-water" fish, such as bass and carp (Lorz et al. 1979). Juveniles and fry are typically more sensitive than adults.

Laboratory studies conducted on aquatic organisms often show toxic effects at one-tenth to one-hundredth of the concentration reported for fish species. Therefore, while fish species may not suffer direct toxic effects, their food sources could be reduced or eliminated.

If toxic concentrations were to occur, it is likely that not all individuals in the aquatic system would be affected. Some individuals would leave the area or would exhibit greater tolerance to the herbicide (Norris et al. 1983). Repopulation of the area would occur through local survivors, migration, or hatching. With increasing distance downstream from the project, peak concentrations of herbicide residues would decrease, reducing the likelihood of ecosystem impact (Newton and Norgren 1977).

The maximum concentration reported from monitoring within the Region in 1980-83 was 0.19 parts per million. As footnoted in Table IV-10 (in the soils section of this chapter), the majority of herbicides have 96-hour LC_{50} values (concentration which kills 50 percent of the test organisms in a 96-hour period) of greater than 10 parts per million.

Of the 235 samples collected in the Region during this 4 year period, 203 had no detectable residue. See the preceding discussion on water in this chapter for further discussion of monitoring results.

There are too many variables to accurately predict effects on aquatic ecosystems from sublethal chemical contamination. Therefore, mitigation measures (see Chapter II, Herbicides) have been developed

to keep herbicides out of surface water and prevent exposure.

These include buffer strips on all live streams, measures to control drift, measures to reduce the chance of accidental spills, and monitoring to make sure these measures are effective. According to Norris et al. (1983), unsprayed corridors along streams will prevent alteration of terrestrial ecosystems that influence aquatic ecosystems, and will also prevent changes in aquatic communities due to use of herbicides.

Conclusion. Mitigation measures regulating use of herbicides should prevent entry of biologically significant levels into surface waters. Short-term, acute concentrations may occur due to accidental spills or unpredicted weather conditions during or immediately after application.

Alternatives A and C, which prohibit use of herbicides, will prevent exposure of fish to residues. The prohibition on aerial application under Alternative E will reduce contamination by direct application and drift, greatly reducing the risk of a substantial concentration occurring. Alternative D allows limited use of herbicides, with a low risk of contact with fish populations. An increasing number of acres is treated in Alternatives E, B, F, and G, with increasing risk of impacts on fish populations.

Cumulative and Synergistic Effects

Potential cumulative and synergistic effects could stem from increased sedimentation, change in the quantity and timing of flows, and chemical contamination of surface waters due to combined activities in a watershed. See the preceding sections on soil and water for further discussion of these impacts.

Stream channels not confined by bedrock are shaped by their peak flows and sediment loads. A change in peak flows, summer base flows, and the sediment load in a stream could result in a loss of fish habitat (Brown 1974). Coats et al. (1985) found that significant filling of pools and burial of riffles by sand occurred during and after a peak flood in a California coastal stream.

Change in summer base flows, timing of peak flows, and sediment load could also adversely affect fish spawning and feeding. The changing flows can eliminate spawning sites or disrupt conditions of flow favorable for egg survival. Turbid waters can reduce fish feeding success (Everest and Harr 1982b).

However, effects on these aspects of channel hydrology due to vegetation management activities are minor compared to timber harvest (Osborn 1980) or road construction (Yee and Roelofs 1980). Cumulative effects analyses associated with these activities will consider impacts on fisheries resources, as required by the National Environmental Policy Act.

Simultaneous exposure to more than one herbicide formulation is highly unlikely, because residues are rapidly degraded or diluted in aquatic systems, and repeated applications on an annual basis are rare (see Soils, this chapter).

Mitigation measures designed to control direct application, drift, mobilization in ephemeral channels, surface runoff, and leaching will prevent exposure to toxic concentrations of herbicides. The properties of the herbicides used, as well as these precautions will also prevent buildup of herbicides in aquatic environments between treatments.

Conclusion. Dispersion of activities within a watershed is the key to avoiding cumulative effects. Activities on lands in other ownership, and effects of other activities on National Forest lands (such as road construction, timber harvest, and grazing) will be considered when planning projects under all of the alternatives.

Specific Lands and Areas

In environmental analysis, special attention is also given to potential effects on prime farmland, rangeland, and forest land; on wetlands and floodplains; and on urban quality and the built environment.

There are environmental effects of the alternatives on many aspects of forest and rangeland—these have been described throughout this chapter. There are no foreseeable effects on prime farmland.

Wetlands and floodplains will be protected by management to meet the requirements of Executive Orders 11988 and 11990. Mitigation measures to protect riparian areas and water are part of all alternatives (see Chapter II). These mitigation measures minimize or avoid the potential adverse impact of vegetation management activities, and no impact on wetlands or floodplains is foreseen.

Mitigation measures occasionally fail or are accidentally misapplied. The risk of this is slightly greater with the alternatives that would tend to manage vegetation aggressively with corrective strategies (Alternatives G, B, A, and F).

Urban quality could be influenced by variations in air quality. The management of vegetation around the built environment in recreation sites, and administrative sites, and along rights-of-way varies by alternative. These environmental effects have been identified earlier in this chapter.

Insect and Disease Conditions

There are no measurable differences between alternatives A, B, D, E, F, and G in terms of effects on forest disease and insect populations. A general effect of all alternatives is that the conversion of existing wild stands to a regenerated or managed condition will reduce the severity of damage due to insects and pathogens. This is a reflection of improved health and vigor of managed stands as density management principles are employed, and as overmature or decadent stands are replaced.

Site preparation and release from competition are important steps in the sequence of events needed to bring about this conversion in many cases. Pest-host interrelationships, however, can only be addressed on a site-specific basis and within the context of damage thresholds determined by management objectives. Alternative C (no vegetation management) would result in an increase in the frequency and severity of damage from insect and disease agents in comparison with other alternatives.

Land Uses

Because land ownership patterns vary extensively within Forest boundaries as well as adjacent to National Forests, implementation of a particular alternative could have significant effects on lands of other owners. These effects can be either positive or negative, depending on the use of the land and the perspective of the landowner.

Alternatives that restrict or eliminate prescribed fire (Alternatives C, E, and F) could have a negative effect on included or adjacent lands, in that the risk of wildfire is increased. A positive effect of these alternatives could be an improvement in air quality (for a more detailed discussion on these effects, see Chapter IV sections on fire and air quality).

Alternatives that restrict or eliminate use of herbicides (Alternatives A, C, and E) have both positive and negative effects on other lands and landowners.

In those areas where active, aggressive programs to combat noxious weeds are in effect, non-use of herbicides by the Forest Service can have a detrimental effect on efforts to effectively control those weeds (see Chapter III, Noxious Weeds). A positive side to the use of alternatives that restrict herbicides is the favorable results obtained: no spray "drift" onto private land; no degradation of scenic values from "brown out"; no adverse effects from herbicides on wildlife and fish; and no adverse effects on public health from herbicides.

Methods of vegetation management that utilize off-road mechanical equipment could cause soil compaction and surface erosion. This, in turn, could have an impact on lands adjacent to and below the affected areas (see Chapter IV, Soil Resources).

Manual and biological methods are estimated to have low impacts on other lands.

Use of herbicides on National Forest lands and resulting effects can be reasonably predicted and mitigation measures put in effect. Large-scale use of herbicides by those landowners within National Forest boundaries and by those adjacent to Forests is more difficult to predict. However, established, regular coordination meetings between large landowners and governmental agencies help greatly in predicting potential problems and planning for any necessary mitigation measures.

Recreation

The control of vegetation for recreation purposes varies little in outputs and costs from alternative to alternative. Vegetation management techniques historically used for recreation sites consist almost exclusively of manual and mechanical methods. Herbicide sprays have been a preferred treatment for poison oak and other toxic plants. In the past, herbicides were applied in "spot" applications rather than broadcast spraying.



Though herbicides have been a preferred treatment for poison oak and other toxic plants, vegetation management techniques historically used for recreation sites consist almost exclusively of manual and mechanical methods.

For those alternatives that allow use of herbicides (Alternatives B, D, E, F, and G), vegetation management may affect the availability of recreational opportunities through site closures, wildlife habitat changes, and the loss of edible fruits. Control of noxious weeds and

toxic plants with herbicides may require temporary closure of areas, or warnings of possible contamination.

Since broadleaf plants which produce edible berries are included in the target species, there will be a temporary loss of berry picking opportunities in areas treated with herbicide. This could occur under all alternatives that allow herbicide use for such activities as noxious weed control, conifer release, and rights-of-way maintenance. Along treated roadsides there could be a loss of easily accessible berries.

For those alternatives that allow prescribed burning, (Alternatives A, B, D, E, and G), air quality could be a problem for both developed recreation sites and dispersed recreation. Depending on timing and location, prescribed burning for programs such as range improvement, wildlife habitat improvement, plantation site preparation, and fire hazard reduction could have an effect on air quality for recreation users (see Chapter IV, Air Quality, for further discussion).

Facilities

The control of vegetation around Forest Service facilities (offices, dwellings, ranger station compounds, etc.) varies little from alternative to alternative. Almost all vegetation management is by manual or mechanical methods, with spot applications of herbicides for poison oak and other toxic plant control.

For those alternatives that do not allow herbicides (Alternatives A and C), other methods of dealing with toxic plants will be needed. Both cutting and burning have been used to control them, but this exposes employees to toxic effects and generally affords only temporary results.

Rights-of-Way

The effects on rights-of-way (for roads and highways, utility corridors, trails, and railroads) attributable to vegetation management is based on the degree to which the vegetation is manipulated.

Insufficient (or no) vegetation management activities could compromise safety along roads by not providing adequate sight distances; allow power outages from encroaching vegetation along utility corridors; contribute to wildfires along railroad rights-of-way; and lead to some environmental damage and loss of investment.

Roads and highways are particularly vulnerable to lack of treatment of unwanted vegetation along their rights-of-way.

For roads included under the Highway Safety Act of 1966, maintenance that assures public safety is required. To provide safe and efficient traffic movement, roadways and roadsides are to be maintained in a way consistent with the design standards used in construction. Management of vegetation is particularly important for providing safe sight distances for stopping; preventing restriction of roadway width; and providing adequate drainage to prevent safety problems.



Roads and highways are particularly vulnerable to lack of treatment of unwanted vegetation along their rights-of-way. Management of vegetation is especially important for providing safe sight distances for driving; preventing restriction of roadway width; and providing adequate drainage to prevent safety problems.

Alternative C could eventually lead to some Forest road closures because of lack of vegetation control. Alternative A, at the costs shown in Table IV-15, would provide the vegetation control necessary to provide safety.

If Alternative A were implemented without the necessary funds, total miles of roads brushed would be reduced, resulting in reduced standards (some roads open to ordinary vehicles would become accessible to high-clearance vehicles only, for example), or leading to possible future road closures. Road closures become necessary when vegetation obscures safe sight distances or hinders drainage. This condition could result if funds available are not sufficient to accomplish the required work.

For the 88,000 mile Pacific Northwest Region road system, if Alternative A were implemented, it would cost approximately \$1,750,000 more for vegetation control than for Alternative B, which is a likely Regional level. Alternatives E and F have costs similar to Alternative B (see Table IV-15).

Regionally, the annual average cost of treating Forest roads between 1980 and 1983 was estimated at approximately \$2 million. About 12,000 miles per year were treated.

Alternative D treats the same number of miles of road as does

Table IV-15

Road Maintenance Cost by Alternative

Alternative:	A	B	C	D	E	F	G
<i>Source</i>							
Costs (in million \$)	4.02	2.28	2.44	2.42	2.25	2.26	2.69
Miles (of work accomplished)	12,660	12,660	8,842	12,660	12,636	12,660	14,884

Alternative B, but with annual costs that are approximately \$140,000 higher. This increase is due to the higher initial cost of implementing biological controls. The costs for Alternative D two decades and beyond are the lowest of all alternatives—by approximately 15 percent—as the higher initial costs begin to pay off in reduced maintenance costs.

Alternative C's costs are up over \$160,000 and roadside treatment is down by almost 4,000 miles in comparison to Alternative B. Alternative G has increased costs in proportion to increased miles treated, which, based on average costs, is equal to Alternatives B, E, and F.

Although other Federal, state, and county agencies have sole responsibility for performing maintenance on their roads and facilities, the 1984 injunction against using herbicides applies to all lands under Forest Service jurisdiction. In other words, those agencies that operate roads and facilities under permit from the Federal government across National Forests in the Pacific Northwest Region are also currently prohibited from using chemical methods of vegetation management on those easements.

The Oregon Department of Transportation reports costs for those alternatives that do not allow herbicides (Alternatives A and C) to be about \$124,000 more annually. This increased cost is for the short-term—five to eight years. Costs over the long-term will be even higher as the right-of-way becomes reinfested with unwanted vegetation. Increased amounts of unwanted vegetation requires additional manpower and equipment to control, thus increasing costs and inconvenience to the motoring public from more equipment operating in the roadway.

The Washington State Department of Transportation reports similarly high costs for Alternatives A and C. Long-term effects of not being able to use herbicide treatments include reduced surface drainage from pavements; deterioration of pavement surface contributing to unsafe driving conditions; loss of integrity of roadside hardware

(signs, guard rails, and guideposts) due to accelerated deterioration or obscured visibility; and inadequate sight distance at intersections, on curves, and at game trail crossings.

It is anticipated that alternatives that do not allow herbicide use will result in additional miles of roads not being treated. The possibility of tort claims because of unsafe sight distance and drainage conditions will require development of a long-term management strategy, possibly resulting in closing some of the roads currently kept open.

Paved roads are especially vulnerable to lack of vegetation management. Vegetation growing next to paved surfaces prevents water from draining from beneath the pavement. This leads to a saturated subgrade, which generally results in structural failure to the pavement and increased reconstruction and maintenance costs. In addition, vegetation can restrict surface drainage from paved roads. This may result in excess water on the driving surface, which can result in hydroplaning. Herbicides have proven to be an effective tool in controlling this type of vegetation.

From a visual standpoint, vegetation along roadsides that has been treated with herbicides is subject to foliage discoloration (brown out). This condition is usually temporary, lasting less than six months. The duration can be reduced by mechanically treating the dead vegetation.

Mechanical treatments of vegetation along roadsides can sometimes leave a ragged, ungroomed appearance. Depending on timing of the treatment, this condition may no longer be apparent in as few as four to six weeks on West-side Forests, and within two to four months on East-side Forests.

Scenery

The National Forests of the Pacific Northwest Region have a variety of landscapes visible from many travel routes, including wilderness trails, developed recreation sites, lakes and rivers, and mountain tops and ridges.

Areas with a high degree of landscape variety that are viewed by many visitors are considered the most sensitive to changes. Areas with very little or no landscape variety which are not viewed by many visitors are considered less important for their scenic qualities.

The degree of contrast between human activity and the natural landscape determines its visual dominance. The degree of visual dominance created by vegetation management is a result of several factors:

- 1) the extent of the affected area (dominance increases as the

visible portion of the project increases);

2) the shape of the project area (unnatural geometric lines and angles would contrast more than lines that follow the natural landscape character);

3) vegetation composition (variety, distribution of total vegetation cover, and target species);

4) natural openings (size and distribution);

5) soil color contrast (lighter soil colors have greater contrast potential); and

6) slope (as slopes increase, greater portions of the management activity will be visible).

Every vegetation management method will affect visual resources to some degree. The extent of the effect is ultimately determined by how well the treatment blends with the character of a given landscape.

Cultural Resources

The major purpose of the Region's cultural resource management program is to identify and preserve cultural resources, as specified by the various federal laws, regulations, and policies.

From the perspective of cultural resources, vegetation management is only one phase of any given program. Timber sale and road building activities will have already altered the landscape to the greatest extent. The corresponding impact to cultural resources from followup vegetation management is expected to be low to moderately low.

Of the seven alternatives, alternatives that allow use of off-road mechanical equipment as a method to control vegetation will probably have the greatest impact on cultural resources. Alternative C, with the least amount of vegetation manipulation, should have little or no impact on cultural resources. Prescribed burning, use of herbicides, and manual methods are estimated to have low impacts on cultural resources.

Federal law requires the National Forests to identify and negate or mitigate adverse impacts on eligible cultural resources that would result from any proposed undertaking. Specific mitigation measures for eligible resources will be determined on a case-by-case basis.

Energy Consumption and Production

Petroleum fuels (for vehicles, large and small machines, and other uses) are consumed during the treatment of unwanted vegetation for all of the alternatives. Petroleum used for managing vegetation is a small fraction of the total amount used for general management of the National Forests. In that context, there is no significant variation between the alternatives, except for Alternative C.



Those vegetation management alternatives that emphasize increased utilization of logging residues are likely to provide additional sources of energy—for example, firewood for homes and “hog fuel” for industrial use.

Debris from logging activities provides potential fuel for domestic and industrial applications. Alternatives that emphasize increased utilization of logging residues (Alternatives D and F) are likely to provide additional sources of energy—for example, firewood for homes and “hog fuel” for industrial uses. Some counterbalancing of this effect would occur with the expected reductions in harvest in these alternatives. The advantages of using this material are not always clear. Other fuels may be less expensive, and there are instances in which the use of wood-burning appliances must be restricted.

4 Environmental Consequences

1. The first of the environmental consequences of the proposed project is the potential for air pollution. The project involves the construction and operation of a large industrial facility, which will generate significant amounts of air pollution. This pollution will be in the form of particulate matter, sulfur dioxide, and nitrogen oxides. These pollutants can have a variety of adverse effects on the environment, including the formation of acid rain, the depletion of the ozone layer, and the contribution to global climate change.

2. Another major environmental consequence of the project is the potential for water pollution. The project will require the use of large amounts of water, and this water will be discharged into the local waterways. This discharge will increase the temperature of the water, which can have a detrimental effect on the aquatic life. Additionally, the project will generate a large amount of wastewater, which will also be discharged into the waterways. This wastewater contains a variety of chemicals and pollutants that can be harmful to the environment.

3. The project will also have significant impacts on the local land resources. The construction and operation of the facility will require the clearing of large areas of land. This clearing will result in the loss of natural habitat and the disruption of local ecosystems. Additionally, the project will generate a large amount of solid waste, which will need to be disposed of in a safe and environmentally sound manner.

4. Finally, the project will have significant impacts on the local community. The construction and operation of the facility will create a large number of jobs, which will provide a source of income for the community. However, the project will also generate a large amount of noise and vibration, which can be a nuisance for the residents. Additionally, the project will increase the demand for local infrastructure, such as roads and public services, which may not be able to handle the increased demand.

Chapter 4

Environmental Consequences

Human Health Effects

Human Health Effects

■ *Characterization of Risk For 16 Herbicides*

The toxicity of the 16 herbicides used in vegetation management has been evaluated in particular detail for this EIS. This evaluation, including both quantitative and qualitative analysis, was undertaken based upon the high degree of concern expressed in public comments, and because of a court injunction requiring further analysis of the health impact of these herbicides.

A quantitative worst case analysis was developed under contract with Labat-Anderson Inc. (LAI), and is included in Appendix D. LAI worked closely with the Environmental Protection Agency (EPA) to obtain the latest information being evaluated for the reregistration of these herbicides. They also did a review of the scientific literature. A major portion of the LAI analysis was devoted to developing an array of possible application scenarios to assess potential exposures to the public and to contractors applying the herbicides.

In addition, the Forest Service contracted with the University of Washington (UW) to provide expertise in the fields of toxicology and public health. Through this arrangement, a qualitative evaluation of available information on herbicide toxicity was developed.

Also reviewed for this EIS are several other sources of information. These include the "Worst Case Analysis Study on Forest Plantation Herbicide Use" prepared for the Department of Natural Resources, State of Washington, by K.S. Crump and Company, Inc. (Crump 1986); the "Medical Toxicology Reviews" produced by the California Department of Food and Agriculture, Division of Pesticide Management; and "Registration Guidelines" and "Registration Standards" produced by the U.S. Environmental Protection Agency, Office of Pesticide Programs.

The University of Washington team did a new review of the literature, drawing upon the studies identified by LAI, as well as those used by Crump. This review updated and extended the survey of the scientific literature. When possible, original studies were reviewed. However, it was necessary to rely upon published reviews of studies in most cases. In all cases, an effort was made to document clearly where information was obtained so that it could readily be reviewed by the public. Based primarily upon new or previously unreferenced

studies, the University of Washington team has updated some of the toxicity data published by LAI.

A major goal was the evaluation of the adequacy of the information and data upon which the characterization of herbicide toxicity is based. The adequacy of each study used is rated in the toxicology summaries in Appendix H. Ratings of the adequacy of total information in each of seven types of toxicity were based upon the number of studies, the adequacy of the studies, and the agreement between these studies.

These ratings of adequacy are not hard scientific facts, but a consensus opinion of the members of the University of Washington team. Differences of interpretation existed within the team, as they do in the general public. These differences are expressed in the degree of certainty or uncertainty noted in these evaluations.

Overview of Risk Characterization

The process of risk assessment by government agencies was studied by the National Research Council Committee on the Institutional Means for Assessment of Risks to Public Health (the NRC Committee). The NRC Committee found that risk assessment was a distinct and separate function from risk management, although it is clearly related to risk management:

"Risk management is the process of weighing policy alternatives and selecting the most appropriate regulatory action, integrating the results of risk assessment with engineering data and with social, economic, and political concerns to reach a decision." (NRC Committee, 1983, p. 3)

As the NRC Committee noted:

"Risk assessment is an analytic process that is firmly based on scientific considerations, but it also requires judgments to be made when the available information is incomplete. These judgments inevitably draw on both scientific and policy considerations." (p. 48)

"Two kinds of policy can potentially affect risk assessment: that which is inherent in the assessment process itself and that which governs the selection of regulatory options. The latter, risk management policy, should not be allowed to control the former, risk assessment policy." (p. 49)

Risk assessment can be classified into four conceptual components in which problems and solutions can be more readily understood:

1. *Toxic hazard identification*, which determines whether or not a particular herbicide is causally linked to potential adverse health outcomes.

2. *Dose-response assessment*, which determines the probability of the adverse outcome from various levels of exposure.
3. *Exposure assessment* which determines the level, sources and time course of actual exposures.
4. *Risk characterization*, which describes the nature and estimates the magnitude of the risk for humans.

Each step involves some components with uncertainty. The uncertainty may be due to missing information, or gaps in scientific theory. Whenever uncertainty is encountered, a decision—based upon scientific knowledge and policy considerations—must be made. The term scientific judgment is used to distinguish this decision from policy decisions made in risk management.

The sum of all the scientific judgments made is called the risk assessment policy, and could have a substantial impact upon the final risk characterization.

An evaluation of seven types of toxic effects was made for each of the 16 herbicides. These include general systemic toxicity (any toxic reaction not limited to areas of direct contact and not included in the following groups); mutagenicity (the ability to induce alterations in the genetic structure of a cell); carcinogenicity (the ability to produce or promote cancer); reproductive toxicity (the ability to adversely alter reproductive capability); developmental toxicity (any adverse effect due to exposures prior to birth); neurotoxicity (the ability to damage the nervous system); and immunotoxicity (the ability to damage the immune system).

Four types of information are generally available for determining toxicity. These include epidemiologic data (from studies of human populations), animal bioassays (studies of test groups of animals), short-term assays (tests using micro-organisms, animal cells and tissues, and sometimes intact animals), and comparison of molecular structures. Many scientific judgments must be made in using such information.

There is no universally accepted test that is specific for determining human risk. Which types of test evidence are used, and the weighting given to each, are scientific judgments. In this EIS, toxicity analyses are based primarily upon animal bioassays. Limited human epidemiology data were found on 2,4-D, 2,4-DP, and amitrole. Short-term studies were used for evaluating mutagenic potential, which also influenced assessment of carcinogenic risk.

While there are generally accepted statistical definitions of what constitutes a clear and unambiguous positive result in a test, many actual results are not so clear. The outcome of a test may also depend upon the effect measured (e.g.: all tumors vs. only malignant

Toxic Hazard Identification

tumors (which can spread and invade normal cells). Sometimes using a different measure or end point can change the results of a test. How to choose effect measures and interpret ambiguous results is another area of judgment.

For many herbicides, there are both positive and negative results. What weighting should be given to each type of result? Many factors go into such a weighting, including the quality and consistency of the studies. Uncertainty in this area is reflected in the adequacy ratings of information available for each herbicide (see Appendix H). Summaries of the quality of information are included in Tables IV-19 through IV-23.

Many of the above scientific judgments are necessary because of gaps in scientific theory. Additional judgments occur when there are no tests, or only inadequate tests, in some areas.

Dose Response Assessment

As with hazard assessment, there are many scientific judgments involved in dose response assessment. Two particularly controversial areas are how to extend test results across species and to dose levels whose effects cannot be measured directly.

For example, many of the data available for human risk assessment are based upon animal experiments. How useful are data on animals for predicting human risks, and what kind of conversion factor should be used? Numerous reviews have examined this question in an effort to improve our ability to make these comparisons. In general, tests in animals do seem to be predictive (Hart & Fishbein 1985; Davidson, Parker & Beliles 1986; and Calabrese 1983).

Animal tests, and even human epidemiology, generally look at populations with exposures much higher than those we anticipate to occur routinely. This is necessary because we want to be able to detect an effect with relatively few observations. However, there is disagreement about how to predict the effects of low doses from effects observed at relatively high doses.

In this analysis, the dose-response relationship is evaluated for general systemic toxicity, reproductive toxicity, and developmental toxicity using animal "no observable effect levels" (NOEL's). Carcinogenicity is evaluated using animal "lowest observable effect levels" (LOEL's). No dose-response ranking is made for neurotoxic and immunotoxic effects.

In addition, LAI quantitatively estimated cancer potency using a one-hit regression model and the upper 95 percent confidence interval for effect, using data from animal studies. These estimates are included in Appendix D.

Assessment of exposure is based upon so many variables that it is difficult to describe the full range of scientific judgments required. However, two major variables include 1) the method of transport of the herbicide through environmental media (air, water, soil, etc.), and 2) the route of exposure (e.g., inhalation, skin absorption, ingestion, etc.).

Multiple scenarios of both public and applicator exposures were developed by LAI. The University of Washington team reviewed these scenarios and others by Crump. It found these results generally consistent with each other, and with the published literature. Three scenarios developed by LAI were chosen to represent the possible range of exposures and are reviewed below. More specific data are in the LAI assessment included in Appendix D.

Exposure scenarios are developed as either routine or accidental. Within routine operations, realistic scenarios were developed for herbicide applicators, and both routine and worst case scenarios were developed for those members of the public who might be exposed to herbicides.

Application rates for aerial and backpack realistic and worst case scenarios are listed in Table IV-16.

Table IV-16

Application Rates for Realistic and Worst Case Assessments
(pounds of active ingredient per acre)

	Aerial		Backpack	
	Realistic	Worst Case	Realistic	Worst Case
<i>Amitrole</i>	2.00	4.00	2.00	5.00
<i>Asulam</i>	2.40	3.34	1.20	3.34
<i>Atrazine</i>	3.75	4.00	3.00	4.00
<i>Bromacil</i>	—	—	4.00	10.00
<i>2,4 -D</i>	2.50	4.00	2.00	4.00
<i>2,4 -DP</i>	2.00	2.50	2.00	4.30
<i>Dalapon</i>	4.00	10.00	4.00	12.00
<i>Dicamba</i>	1.00	4.00	0.50	4.00
<i>Diuron</i>	—	—	4.00	6.00
<i>Fosamine</i>	3.00	12.00	3.00	11.50
<i>Glyphosate</i>	2.00	5.00	1.50	5.00
<i>Hexazinone</i>	2.50	3.00	1.12	3.00
<i>Picloram</i>	1.00	5.00	1.00	4.00
<i>Simazine</i>	4.00	5.00	2.00	4.60
<i>Tebuthiuron</i>	1.00	6.00	1.50	6.00
<i>Triclopyr</i>	2.00	8.00	2.00	8.00

(From LAI-Appendix D)

Exposure Assessment

The routine backpack spraying scenario involves two applicators spraying six acres (three acres each). The routine helicopter (aerial) spraying scenario involves one crew spraying four 40-acre sites.

The estimated exposures for three scenarios is listed in Table IV-17 below:

Table IV-17

Estimated Exposures From One-Day Application

	Routine-Realistic	Accidental-Worst Case	
	Applicator (Backpack)	Public (Aerial)	Public (Aerial)
	(mg/kg)	(mg/kg)	(mg/kg)
<i>Amitrole</i>	0.0033	0.0040	0.31
<i>Asulam</i>	0.20	0.0049	0.41
<i>Atrazine</i>	0.49	0.0076	0.69
<i>Bromacil</i>	0.66	0.0019*	0.81
<i>2,4 -D</i>	0.20	0.0051	0.26
<i>2,4 -DP</i>	0.21	0.0041	0.33
<i>Dalapon</i>	0.66	0.0081	0.81
<i>Dicamba</i>	0.041	0.0020	0.24
<i>Diuron</i>	0.66	0.0019*	1.30
<i>Fosamine</i>	0.49	0.0061	0.97
<i>Glyphosate</i>	0.25	0.0041	0.41
<i>Hexazinone</i>	0.18	0.0051	0.49
<i>Picloram</i>	0.0079	0.0020	0.20
<i>Simazine</i>	0.33	0.0081	0.41
<i>Tebuthiuron</i>	0.25	0.0020	0.49
<i>Triclopyr</i>	0.33	0.0041	0.65

* Public Routine-Realistic exposures are estimated from backpack spray operations for Bromacil and Diuron - two herbicides not aerially sprayed.)
(From LAI - Appendix D)

Routine Exposures for Backpack Sprayers

Applicator exposure estimates were derived from actual field studies on five herbicides (amitrole, 2,4-D, 2,4-DP, dicamba, and picloram). Exposure was determined by urine sample for workers following routine precautions, but not wearing special protective equipment. Exposures for the other herbicides were estimated by extrapolating from 2,4-D exposures, adjusting for application rates and skin absorption.

A unit dose for workers (dose associated with spraying one acre with one pound of active ingredient per acre) was calculated.

Worker doses for the various scenarios were then calculated by adjusting for application rates and number of acres treated.

Of the eight scenarios for workers in LAI, the application of herbicides by backpack generally resulted in the highest exposure. In routine application scenarios, backpack sprayers receive about five times the dose of mixer/loaders in helicopter spraying, and about eight times the dose of the pilot. Most other operations involve considerably less exposure.

Possible Public Exposure From Routine Aerial Spraying

There are many estimates for public exposure. The estimated exposure for a “nearby resident” is the highest routine-realistic spraying exposure estimated by LAI. It includes exposure from direct dermal contact due to drift over two square feet of unprotected skin, eating 400 grams (0.9 pounds) of vegetables contaminated by drift, drinking one quart of water contaminated by drift, and entering a sprayed area with secondary skin contact from sprayed vegetation. Virtually all of the calculated exposure is due to eating the vegetables and drinking the water.

Drift deposition was derived from actual measurements (adjusted for application rates) and assumes conditions which meet current guidelines for aerial spraying. However, wind direction was assumed directly toward the targets of concern and no allowance was made for herbicide degradation. Water contamination was based on a source six inches deep. Assumed distances from helicopter to vegetables was 600 feet, and to the water, 50 feet.

Possible Public Exposure From Accidental Spraying

The “nearby resident” was again chosen as the general worst case. The exposures are similar to the routine aerial spraying scenario except that direct spray with full application formula is assumed. In this scenario direct dermal absorption and eating vegetables are the primary routes for the calculated exposure, although all routes do contribute.

Differences Between Worker and Public Exposures

Once exposures are determined, there are still several judgments to be made. The most controversial of these is the relative importance of short-term vs. long-term exposures, and how to adjust for these differences.

Spray applicators are repeatedly exposed to the various herbicides during the spraying season, and are likely to be exposed year after year for the duration of their working lives.

On the other hand, exposure of any member of the public from

any of these scenarios is not probable: for those individuals who do get exposed, it is not likely to occur more than once or twice. This is because historically less than two-tenths of one percent of all forest lands have been sprayed per year. Most aerial spraying is done for silviculture (the growing of trees), and for this purpose any one stand of trees is sprayed only a few times over its life (80-120 years). Public exposure from accidental spraying is less likely, and would not be expected to occur more than once to any individual.

No adjustment for the frequency of exposures has been made in risk estimates for general toxicity, reproductive effects, and developmental effects. Comparing infrequent human exposures to NOEL's based upon daily animal exposures (over months or years) makes these risks estimates more protective. Thus, the public has an extra margin of safety built into these estimates compared to applicators.

However, it cannot be guaranteed that some effects will not occur from single exposures. This is probably most true for reproductive effects, which may have periods of susceptibility which are measured in days rather than in weeks or months. It may also be true for hyper-sensitive reactions among members of the public.

Lifetime Exposures

Average daily lifetime exposure is generally used for calculating carcinogenic risks or hazards. Two lifetime exposure scenarios are used in this risk characterization. These lifetime exposure scenarios are designed to represent the worst case exposure due only to Forest Service use of herbicides.

Lifetime exposure for a backpack applicator assumes a working life of 40 years, and an average of 15 days worked per year for the Forest Service. Thus, the routine-realistic workday exposure is multiplied by 600. The total is divided by 25,550, which represents the number of days in a 70 year lifetime. This yields the average exposure per day over 70 years.

Lifetime exposure for a "nearby resident" assumes that the resident receives the dose calculated in the routine-realistic scenario once per year for 40 years. It also assumes a one time accidental exposure. This sum is again divided by 25,550 to yield the average exposure per day over 70 years.

Risk Characterization

Risk characterization uses the information gathered in the other stages to represent the overall situation. The assessment of toxicity is joined with levels and probability of exposure to estimate risk. How this presentation is made, and in particular, how uncertainty is handled, will influence all other scientific judgments in this process.

Included in the results of the qualitative analysis are estimates

of the NOEL's and LOEL's. These measures are presented with an evaluation of the adequacy of the data upon which they are based. These measures do not represent "safe" levels, but represent a risk of about 10 percent or less (the detection limit of animal studies).

How the toxicity data are used in risk characterization depends upon the toxic effect being characterized and theory about how this effect is produced. One major consideration is whether or not there exists a "threshold"—a dose of chemical below which there is no significant effect.

It is generally believed that, for non-carcinogenic effects, the defense and repair systems of the human body can sustain a certain level of exposure to a toxin without any significant damage. On the other hand, it is widely believed that carcinogenicity can be initiated with a single "hit" or minute exposure to a carcinogen if it interacts with the genetic coding of a cell. Higher exposures thus represent a greater probability for the disease process to occur.

When considering threshold effects, one standard way of applying animal NOEL's to human exposure is to use a ten-fold adjustment for extrapolating from an animal model to humans. An additional ten fold adjustment is usually made to account for variability within the human population. Thus, an animal NOEL is commonly divided by 100 to be applied to a human population (Murphy 1986).

This ratio (animal NOEL divided by the estimated human exposure) can be used to evaluate how confident we are that no adverse effect will occur when humans are exposed at the estimated level. For example, when humans are exposed at levels greater than those that cause observable effects in animals (with a ratio less than one), our confidence that humans will experience no adverse effect is very low.

When human exposures range between the animal NOEL and the exposure level obtained by applying the extrapolation formula described above (represented by a ratio between one and 100) our confidence that there will be no adverse effect is uncertain. As the human exposure falls below these values (represented by ratios greater than 100), our confidence grows.

Table IV-18, next page, outlines the "degree of confidence" levels used in the following characterization of risk. It was developed specifically for this evaluation.

Non-threshold effects cannot be evaluated in this manner, because it is assumed that there is a finite risk for any level of exposure. Thus, some "acceptable" or "negligible" level of risk is usually chosen. This level is frequently chosen to be not more than one additional cancer per one hundred thousand, or one million people exposed at the level being evaluated (OSTP 1984; EPA 1976; NRC 1983;

Table IV-18

Degree of Confidence in Risk Evaluation Data

Ratio	Degree of Confidence
Below 1	Very Low
Between 1 - 100	Uncertain
Between 100 - 1,000	Moderate
Above 1,000	High

and EPA 1984). This method requires mathematical modeling based upon theories of carcinogenic mechanisms, and linear or linearized extrapolation of laboratory animal data obtained at high doses to the very low doses estimated for human exposures.

Such modeling for cancer risk has been done by LAI and is presented in Appendix D. However, some authors (Ames, Magaw & Gold 1987), believe that there is insufficient scientific basis for such modeling. Ames et al (1987) proposed a semi-quantitative method for comparing hazards. They used the tumor dose 50 percent (TD_{50}) in rodents (the dose that caused 50 percent of the rodents to develop tumors in long-term test) as a standard of animal cancer potency. They used the estimated average daily exposure in mg/kg over a 70 year lifetime as the human dose. The authors then defined the HERP (Human Exposure dose/Rodent Potency dose) as the human dose expressed as a percent of the rodent TD_{50} .

The following characterization of risk will use an adaptation of Ames' HERP. We call it the LOEL HERP. It is calculated similarly to the Ames HERP, excepting that animal LOEL's for carcinogenicity are used instead of rodent TD_{50} 's. Neither Ames' HERP's nor the LOEL HERP's are estimates of actual risks to the exposed human populations. However, they are useful for comparisons among the potential hazards associated with Forest Service use of the 13 herbicides for which there are carcinogenicity bioassay data.

Ames calculated a number of HERP's for daily or common exposures to be used to put the HERP's for less common exposures into a context. A list of these HERP's and additional information about HERP's is included in Appendix H.

Summary of Epidemiology

Following is a summary of the human epidemiology studies presented in Appendix H. This summary reviews risks associated with phenoxy herbicides (such as 2,4-D and 2,4-DP), plus a brief mention of Amittrole.

A difficulty in using epidemiology studies to evaluate the phenoxy herbicides 2,4-D and 2,4-DP specifically is that another

widely used phenoxy herbicide is contaminated with a dioxin considered to be highly toxic and carcinogenic. This is the 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). While other dioxins are found in 2,4-D and 2,4-DP, these herbicides do not contain TCDD. The toxicity of other dioxins which have been studied is lower than that of TCDD. However, many have not been tested.

Lung Cancer

The association between lung cancer and phenoxy herbicide exposure is evaluated through several cohort studies of exposed workers.

Supporting Evidence. Evidence supporting an association between phenoxy herbicide exposure and lung cancer comes from four studies. These are the studies by Lynge in 1985, by Zack and Gaffey in 1983, by Zack and Suskind in 1980, and by Thiess et al. in 1982. All four involve manufacturing cohorts. The last two involve exposures due to industrial accidents.

These studies are fairly small, and frequently the excess lung cancers do not reach a significant level. It is the consistency of findings that lends some credibility to the few statistically significant findings.

In the Lynge study, workers supposedly had very limited exposure to 2,4,5-T production or to TCDD. In the three other studies, workers were exposed to 2,4,5-T or 2,4,5-trichlorophenol and thus had considerable exposure to TCDD.

Lynge reported a statistically significant increased incidence risk of 2.06 (based upon 11 lung cancer cases) for males employed in the phenoxy herbicide manufacturing and packaging areas (compared to $RR = 1.19$ for the overall plant).

Zack and Gaffey reported a standard mortality ration (SMR) of 1.41 based upon a total of 14 lung cancer deaths. Calendar period specific SMR's showed an increasing risk of lung cancer from 0.0 for the years 1955-59, to 1.11 for the years 1960-69, to 1.81 for the years 1970-77. As 75 percent of the cohort was hired between 1940-59, this trend could be considered to represent a latency period. It would thus be consistent with a causal association. None of these risk ratios were statistically significant.

Zack and Suskind reported an SMR of 1.66 based upon five lung cancer deaths for workers with chloracne—a marker of exposure. This was not a statistically significant risk ratio.

Thiess et al. reported an SMR of 2.3 (based upon three lung cancer deaths), which increased to 2.9 (based upon two deaths) with a 10-year latency period added, and to 4.6 (based upon two deaths) with a 20-year latency period. Only the 20-year latency risk ratio reached statistical significance.

Lynge had demonstrated a greater risk among his highly exposed subgroup than for the general manufacturing cohort. This same effect was demonstrated by Zack and Gaffey using proportional mortality. Thiess et al. demonstrated an increasing risk with increasing latency. This was also demonstrated by Zack and Gaffey. All these results are consistent with a causal association.

Confounding Exposures. Other exposures, either due to other chemical exposures at the plant, or personal habits such as cigarette smoking, could be major confounders of these studies. However, it would be expected that groups of workers in the same plant and with similar jobs would tend to have similar behaviors. Thus, the fact that several studies demonstrate differences between exposed subgroups and the overall workforce in the same factory helps reduce the likelihood of such confounding.

For example, Thiess et al. extended their study to include two internal (in-plant) comparison groups as well as three external groups. They were able to show that all three external groups yielded similar risk estimates, and that their rates closely predicted the observed rates in the internal control groups. Thus, there is no direct evidence of confounding due to differences between external controls and the in-plant population in this study.

Non-Supporting Evidence. There are some studies which do not support the association between phenoxy herbicides and lung cancer. These include the studies by Riihimaki et al. in 1982 and the study by Axelson in 1980. These both involve herbicide applicators.

Riihimaki reported an SMR of 0.85 with a 15-year latency based upon four male lung cancer deaths. The major weakness in this study is that three-quarters of the applicators had less than 8 weeks of recorded exposure.

Axelson had an SMR of 1.0 with a latency of 10 years based upon one lung cancer death among workers applying phenoxy herbicide. The one death was a worker who was also exposed to amitrole (a non-phenoxy acid herbicide). The study did show a non-significant excess of lung cancers for workers exposed only to amitrole.

Conclusions. Based upon these studies of fairly small groups, there is a suggestion that exposure to phenoxy acids may be associated with an increased risk for lung cancer. One difficulty of applying these findings to the use of 2,4-D and 2,4-DP is the question of the role of TCDD. It is very difficult to clearly separate these exposures. However, one of the two statistically significant increases in lung cancer was reported by Lynge, a study with only minor exposure to 2,4,5-T and TCDD.

Stomach Cancer

The association between stomach cancer and phenoxy herbicide exposure is evaluated through several cohort studies of exposed workers.

Supporting Evidence. Thiess et al. (1982) used three external populations and two internal (in-plant) populations as comparison groups. The internal groups had death rates close to those predicted by the external comparison groups. Thiess et al. reported relative risks for exposed workers based only upon the external comparison groups. Thiess reported a relative risk of 4.7 (based upon 3 stomach cancer deaths) for exposed workers, increasing to 5.8 (based upon 2 deaths) with 10-year latencies, and to 8.7 (based upon 2 deaths) with 20-year latencies. All these risk ratios were statistically significant.

Axelsson et al. (1980) reported an overall plant relative risk of 2.2 (based upon 3 stomach cancer deaths), increasing to 3.1 (based upon 2 stomach cancer deaths) when limited to those exclusively exposed to phenoxy acids, and increasing again to 6.1 (based upon 2 deaths) with a 10-year latency period added. Only the latter risk represents a statistically significant increase. Risks were similarly increased for those with mixed phenoxy acid and amitrole exposures, but not for those with exposure to amitrole alone.

Non-Supporting Evidence. Lynge (1985) reported only a minor increased risk factorywide ($RR = 1.29$ based upon 12 stomach cancer cases), with an $RR = 1.36$ (based upon 2 cases) for phenoxy-exposed workers. Riihimäki et al. (1982) reported no increased risk ($SMR = 1.1$ based upon four stomach cancer deaths). Zack and Gaffey (1983) reported a decreased risk ($SMR = 0.63$) based upon only one stomach cancer death.

Conclusions. Based upon these studies of fairly small groups, there is a suggestion that exposure to phenoxy acids may be associated with an increased risk for stomach cancer. One difficulty in applying these findings to the use of 2,4-D and 2,4-DP is the question of the role of TCDD. It is very difficult to clearly separate these exposures.

Leukemia

The association between leukemia and phenoxy herbicide exposure is evaluated through several of the cohort studies which reported cases of leukemia.

Only one researcher, Lynge, reported risk ratios for leukemia. Overall plant risks were non-significantly elevated for females ($RR = 2.1$ based upon 2 leukemia cases). This risk increased to a non-significant 4.0 for phenoxy-exposed females. Males had risk ratios of 1.1 and 1.4, respectively.

Axelson reported two leukemia deaths, as did Zack and Suskind. No risk ratios were calculated, but these numbers appear to be above expected for these small cohorts. No other authors reported leukemia deaths.

There is too little information from these studies to draw any conclusions about the association between phenoxy exposure and leukemia.

Hodgkin's Disease

Two case-control studies have looked specifically at the occurrence of Hodgkin's disease and exposure to phenoxy herbicides. One study (Hardell et al. 1981) done in Sweden reported a statistically significant five-fold risk. A recent study in the U.S. (Hoar, Blair et al. 1986) found no excess risk.

The reasons for this disparity are not clear. The studies appear to have sufficient quality to be given credibility. The cohort studies do not provide much more information, as this is a rare cancer (only two studies reported any cases). One study (Axelson et al. 1980) reported two deaths due to Hodgkin's disease, but no specific risk ratio. Zack and Suskind reported one Hodgkin's disease death and no risk estimate.

It is difficult to reconcile the large risk observed in the Swedish study and the lack of risk in the U.S. study. However, the studies did involve very different exposed populations, one primarily railroad workers, and the other farmers. Despite these conflicting studies, we conclude that a suggestion of an association between phenoxy herbicides and Hodgkin's disease, at least under some circumstances, has been raised.

Non-Hodgkin's Lymphoma

Several case-control studies have looked specifically at the occurrence of Non-Hodgkin's lymphoma and exposure to phenoxy herbicides. Two studies, one in Sweden (Hardell, Eriksson et al. 1981) and one in the U.S. (Hoar, Blair et al. 1986) reported statistically significant five- to six-fold risk ratios. A recent study in New Zealand (Pearce, Smith et al. 1986) found a non-significant small increased risk of 1.4.

The authors of the New Zealand study felt that their findings were not consistent with the other studies. In particular, they believe that their study population was likely to have higher exposures and should have demonstrated as large an effect as the others to be consistent.

There is no reporting of Non-Hodgkin's lymphomas in the various cohort studies.

While there is some conflict to reconcile between the large risks

observed in the Swedish and U.S. studies, and the low risk in the study from New Zealand, the evidence suggests some association between phenoxy exposure and Non-Hodgkin's lymphoma.

Soft Tissue Sarcomas

Several case-control studies have looked specifically at the occurrence of Soft Tissue Sarcomas (STS) and exposure to phenoxy herbicides. Two studies (Hardell et al. 1981, and Hardell and Sandstrom 1979), both done in Sweden on separate populations, reported statistically significant five- to seven-fold increased risks. Two recent studies, one in the U.S. (Hoar, Blair et al. 1986) and one in New Zealand (Smith, Pearce et al., 1984) found little or no excess risk.

STS, a relatively rare type of cancer, was seen in five of the eight cohort studies. In each case this represented an excess, though usually not significant. A statistically significant excess of five-fold (based upon three cases) was reported by Lynge (1985) for workers in the manual services (maintenance) category.

Studies of a number of small manufacturer cohorts reported individual cases. A review by Honchar & Halperin (1981) estimated an excess risk of over 40-fold, based upon three cases in four cohorts compared to national statistics. Additional case reports claim to have found additional cases who worked in manufacture, some possibly from these four cohorts. A total of seven cases diagnosed by pathologists has been reported.

STS is a difficult diagnosis even for pathologists. The National Institute of Occupational Safety and Health (Fingerhut et al. 1983) reviewed these seven cases. Two pathologists familiar with STS concurred with the diagnosis in only five cases.

In addition to the difficulty of diagnosis, there are problems coding STS on death certificates. The International Code for Diseases (ICD) is site oriented. Thus, an STS of the stomach may be coded as a stomach cancer.

Of more immediate concern is that the two Swedish case-control studies selected their cases using primarily histopathologic characteristics, and did not limit selection by site. The New Zealand and U.S. studies identified their cases using the more site-specific ICD classification of 171 (malignant neoplasm of connective and other soft tissue). Thus, while all the studies used cancer registries and cases confirmed by pathology examination, the Swedish studies probably included more sites (such as STS of the stomach). The differences between these studies could well be due to different diagnostic criteria.

The problems with both diagnosis and coding of STS mean that comparisons using death certificates must be questioned. Thus, while

there is some variability of the data, there are some clear differences in technique that could explain these differences. Both case control and cohort studies in various countries have found associations with STS and phenoxy acid exposures.

Summary

Suggestions of association with at least five types of cancer have been found in the epidemiology literature. Each of the five cancers has some statistically significant associations with exposure. While there is no conclusive demonstration of any individual association, the overall suggestion is that phenoxy herbicides in some way initiate or promote cancers, and that this occurs at a level of exposure experienced in various work settings.

Presentation of Data

Tables IV-19 through IV-27 present summaries of the evaluation of toxicity for the 16 herbicides by toxic effect. Each table gives a summary rating of the quality of information available on each herbicide and most provide a NOEL (or LOEL for carcinogenicity) which estimates its potency.

Table IV-19 summarizes general toxic effects and describes the effect(s) seen at the lowest doses. Table IV-20 summarizes reproductive and developmental effects and provides an additional evaluation of effect for developmental effects. Table IV-24 summarizes neurotoxic and immunotoxic effects and gives an estimate of toxic potential but no NOEL. Table IV-22 summarizes both mutagenic and carcinogenic effects, indicating the weight of evidence for or against there being an effect. LOEL's are presented where a potential for carcinogenicity exists.

The adequacy of information on the 16 herbicides across the various types of toxic effects is summarized in Table IV-25. Two herbicides, Diuron and Fosamine, stand out as having the least sufficient information available.

Tables IV-24 through IV-26 indicate the levels of confidence that no adverse human health effects will occur for the estimated human exposure to each of the herbicides in each of three scenarios (nearby residents close to a routine aerial spraying operation; workers spraying by backpack; and accidental, worst case spraying exposures for nearby residents). They are presented for the toxic effects considered to have thresholds (general systemic effects, reproductive effects and developmental effects). When there is insufficient data to estimate NOEL's, the certainty levels are not calculated.

Table IV-27 shows the LOEL HERPs for the sixteen herbicides by three scenarios.

Table IV-19

**Summary of Toxic Effects for 16 Herbicides,
General Toxicity**

Chemical	Quality	Effect	NOEL (mg/kg/day)
<i>Amitrole</i>	M	Thyroid	0.025
<i>Asulam</i>	M	Liver Wt. Fatty Liver	20
<i>Atrazine</i>	M	Body Wt.	1
<i>Bromacil</i>	M	Body Wt. Thyroid & Liver	6.25
<i>2,4-D</i>	A	Kidney Histopathology	1
<i>2,4-DP</i>	A	Liver Clinical Chem.	5
<i>Dalapon</i>	M	Kidney Wt.	15
<i>Dicamba</i>	I	Body Wt.	0.125-3
<i>Diuron</i>	I	?	0.625
<i>Fosamine</i>	M-I	Stomach Wt.	25
<i>Glyphosate</i>	M-I	Pituitary Wt. Kidney Effects	20- >500
<i>Hexazinone</i>	M	Liver Wt. Body Wt.	10
<i>Picloram</i>	A	Liver Wt.	7
<i>Simazine</i>	M	Blood Cell Count	5
<i>Tebuthiuron</i>	M-I	Thyroid Wt. Reduced Growth	12.5
<i>Triclopyr</i>	M-I	Liver Clearance Liver Weight	0.5

Quality of Data:

I = Inadequate information available for evaluating toxicity.

M-I = Marginal but usable information available for evaluating toxicity - widely varying results provide an unstable assessment.

M = Marginal but usable information available for evaluating toxicity - additional studies may significantly change assessment.

A = Adequate information available - more studies unlikely to change assessment.

Table IV-20

Summary of Toxic Effects for 16 Herbicides

Chemical	Reproductive Effects		Developmental Effects		
	Quality	NOEL (mg/kg/day)	Effects Evaluation	Quality	NOEL (mg/kg/day)
<i>Amitrole</i>	I	0.5*	1	A	4
<i>Asulam</i>	M	50	2	M	300
<i>Atrazine</i>	M	>5	2	M	5
<i>Bromacil</i>	M	>250	1?	M	>7.9
<i>2,4-D</i>	A	5	3	M	1.25*
<i>2,4-DP</i>	M	6.25	2-3	A	<25
<i>Dalapon</i>	I	{>300}	2	M	500
<i>Dicamba</i>	M	>500	2-3	A	0.5
<i>Diuron</i>	I	{>125}	1-2	M	12.5*
<i>Fosamine</i>	I	{250}	2-3	I	{21}
<i>Glyphosate</i>	M	10	2	A	75
<i>Hexazinone</i>	M	50	2	M	50
<i>Picloram</i>	M	50	1-2	M	50*
<i>Simazine</i>	M-I	>5	1	A	5
<i>Tebuthiuron</i>	M	>20	1?	M-I	>25 - <237
<i>Triclopyr</i>	M	>30	1-2	A	10

Quality of Data:

I = Inadequate information available for evaluating toxicity.

{ } = Very tentative estimate.

M-I = Marginal but usable information available for evaluating toxicity - widely varying results provide an unstable assessment.

M = Marginal but usable information available for evaluating toxicity - additional studies may significantly change assessment.

A = Adequate information available - more studies unlikely to change assessment.

* = No NOEL observed - estimated by LOEL divided by 10.

Developmental Effects Evaluation:

1 = Little or no evidence for adverse developmental effects in absence of maternal toxic effects.

2 = Evidence for adverse developmental effects, primarily minor abnormalities observed.

3 = Evidence for adverse developmental effects, including some major malformations.

4 = Evidence for severe adverse developmental effects - dose related increases.

Table IV-21

Summary of Toxic Effects for 16 Herbicides

Chemical	Neurotoxicity		Immunotoxicity	
	Quality	Toxic Potential	Quality	Toxic Potential
<i>Amitrole</i>	I	*	I	*
<i>Asulam</i>	I	{1}	I	*
<i>Atrazine</i>	M	1-2	I	{1-2}
<i>Bromacil</i>	I	*	I	*
<i>2,4-D</i>	A	2	M-A	1
<i>2,4-DP</i>	I	*	I	*
<i>Dalapon</i>	I	*	I	*
<i>Dicamba</i>	I	{0-1}	I	*
<i>Diuron</i>	I	*	I	{1}
<i>Fosamine</i>	I	{0}	I	*
<i>Glyphosate</i>	I	*	I	*
<i>Hexazinone</i>	I	*	I	*
<i>Picloram</i>	I	*	I	*
<i>Simazine</i>	I	{1}	I	*
<i>Tebuthiuron</i>	I	{0}	I	*
<i>Triclopyr</i>	I	*	I	*

Quality of Data:

I = Inadequate information available for evaluating toxicity.

{ } = Very tentative estimate.

M-I = Marginal but usable information available for evaluating toxicity – widely varying results provide an unstable assessment.

M = Marginal but usable information available for evaluating toxicity – additional studies may significantly change assessment.

A = Adequate information available – more studies unlikely to change assessment.

Neuro/Immuno Toxic Potential

0 = Very weak evidence of neurotoxicity or immunotoxicity.

1 = Weak evidence of neurotoxicity or immunotoxicity.

2 = Moderate evidence of neurotoxicity or immunotoxicity.

3 = Strong evidence of neurotoxicity or immunotoxicity.

* = No studies available to judge.

Table IV-22

Summary of Toxic Effects for 16 Herbicides

Chemical	Mutagenicity				Animal Carcinogenicity		
	Point Mutation	Clastogen	DNA Repair	Transformation	Quality	Effect	LOEL (mg./kg./day)
<i>Amitrole</i>	A -	A -	A -	A +	M	+	2.5
<i>Asulam</i>	M -	I {-}	I *	M -	A	±	750
<i>Atrazine</i>	A -	M ±	I {+}	M +	M	+	3.5
<i>Bromacil</i>	A -	A -	A -	I *	M	+	250
<i>2,4-D</i>	A -	A ±	A ±	M +	M	±	45
<i>2,4-DP</i>	M -	M ±	M ±	I *	M	+	<25
<i>Dalapon</i>	A -	I {±}	I *	I *	M	-	
<i>Dicamba</i>	A -	M ±	A ±	I *	M	+	125
<i>Diuron</i>	A -	M ±	M -	I *	I	{-}	?
<i>Fosamine</i>	A -	M ±	M -	I *	I	*	?
<i>Glyphosate</i>	A -	M -	M -	I *	M	±	32
<i>Hexazinone</i>	M -	M ±	M -	I *	A	-	
<i>Picloram</i>	A -	M -	I *	I *	M	±	380
<i>Simazine</i>	A -	M +	M -	I *	I	{±}	?
<i>Tebuthiuron</i>	M -	I *	I *	I *	M	-	
<i>Triclopyr</i>	A -	A -	A -	I *	M	±	1.2 - 30

Quality of Data:

I = Inadequate information available for evaluating toxicity.

{ } = Very tentative estimate.

M-I = Marginal but usable information available for evaluating toxicity - widely varying results provide an unstable assessment.

M = Marginal but usable information available for evaluating toxicity - additional studies may significantly change assessment.

A = Adequate information available - more studies unlikely to change assessment.

Effect:

- = Consistently negative or insignificant.

+ = Consistently positive.

± = Equivocal, or inconsistently positive/negative.

* = No studies available to judge.

Table IV-23

Quality of Information on 16 Herbicides by Type of Toxicity

Chemical	Effect:					
	Systemic	Cancer	Reproductive	Developmental	Neurologic	Immunologic
<i>Amitrole</i>	M	M	I	A	I	I
<i>Asulam</i>	M	A	M	M	I	I
<i>Atrazine</i>	M	M	M	M	M	I
<i>Bromacil</i>	M	M	M	M	I	I
<i>2,4-D</i>	A	M	A	M	A	M
<i>2,4-DP</i>	A	M	M	A	I	I
<i>Dalapon</i>	M	M	I	M	I	I
<i>Dicamba</i>	I	M	M	A	I	I
<i>Diuron</i>	I	I	I	M	I	I
<i>Fosamine</i>	M-I	I	I	I	I	I
<i>Glyphosate</i>	M-I	M	M	A	I	I
<i>Hexazinone</i>	M	A	M	M	I	I
<i>Picloram</i>	A	M	M	M	I	I
<i>Simazine</i>	M	I	M	A	I	I
<i>Tebuthiuron</i>	M-I	M	M	M-I	I	I
<i>Triclopyr</i>	M-I	M	M	A	I	I

Quality of Data:

I = Inadequate information available for evaluating toxicity.

M-I = Marginal but usable information available for evaluating toxicity – widely varying results provide an unstable assessment.

M = Marginal but usable information available for evaluating toxicity – additional studies may significantly change assessment.

A = Adequate information available – more studies unlikely to change assessment.

Table IV-24

Estimated Level of Confidence that No Adverse Human Health Effects Will Occur

Based on Public Exposure from Routine-Realistic Aerial Spraying** (Combined Exposures for a Nearby Resident)

Chemical	Effect:		
	Systemic	Reproductive	Developmental
<i>Amitrole</i>	U	*	M
<i>Asulam</i>	H	H	H
<i>Atrazine</i>	M	M	M
<i>Bromacil</i>	H	H	H
<i>2,4-D</i>	M	M	M
<i>2,4-DP</i>	H	H	H
<i>Dalapon</i>	H	*	H
<i>Dicamba</i>	*	H	M
<i>Diuron</i>	*	*	H
<i>Fosamine</i>	H	*	*
<i>Glyphosate</i>	H	H	H
<i>Hexazinone</i>	H	H	H
<i>Picloram</i>	H	H	H
<i>Simazine</i>	M	M	M
<i>Tebuthiuron</i>	H	H	H
<i>Triclopyr</i>	M	H	H

Quality of Data:

U = Uncertain, M = Moderate, H = High.

* Not calculated due to inadequate data.

** Exposures as estimated in LAI risk assessment (Appendix D).

Table IV-25

Estimated Level of Confidence that No Adverse Human Health Effects Will Occur

Based Upon Worker Exposure from Routine-Realistic Backpack Spraying**

Chemical	Effect:		
	Systemic	Reproductive	Developmental
<i>Amitrole</i>	U	*	H
<i>Asulam</i>	M	M	H
<i>Atrazine</i>	U	U	U
<i>Bromacil</i>	U	M	U
<i>2,4-D</i>	U	U	U
<i>2,4-DP</i>	U	U	M
<i>Dalapon</i>	U	*	M
<i>Dicamba</i>	*	H	U
<i>Diuron</i>	*	*	U
<i>Fosamine</i>	U	*	*
<i>Glyphosate</i>	U	U	M
<i>Hexazinone</i>	U	M	M
<i>Picloram</i>	M	H	H
<i>Simazine</i>	U	U	U
<i>Tebuthiuron</i>	U	U	M
<i>Triclopyr</i>	U	U	U

Quality of Data:

U = Uncertain, M = Moderate, H = High.

* Not calculated due to inadequate data.

** Exposures as estimated in LAI risk assessment (Appendix D).

Table IV-26

Estimated Level of Confidence that No Adverse Human Health Effects Will Occur

Based Upon Public Exposure from Accidental–Worst Case Spraying**
(Combined Exposures for a Nearby Resident)

Chemical	Effect:		
	Systemic	Reproductive	Developmental
<i>Amitrole</i>	L	*	U
<i>Asulam</i>	U	M	M
<i>Atrazine</i>	U	U	U
<i>Bromacil</i>	U	M	U
<i>2,4-D</i>	U	U	U
<i>2,4-DP</i>	U	U	U
<i>Dalapon</i>	U	*	M
<i>Dicamba</i>	*	H	U
<i>Diuron</i>	*	*	U
<i>Fosamine</i>	U	*	*
<i>Glyphosate</i>	U	U	M
<i>Hexazinone</i>	U	M	M
<i>Picloram</i>	U	M	M
<i>Simazine</i>	U	U	U
<i>Tebuthiuron</i>	U	U	U
<i>Triclopyr</i>	L	U	U

Quality of Data:

L = Very Low, U = Uncertain, M = Moderate, H = High.

* Not calculated due to inadequate data.

** Exposures as estimated in LAI risk assessment (Appendix D).

Table IV-27

Comparison of Cancer Hazards for 16 Herbicides

Chemical	Worst Case—Nearby Resident			Worst Case—Applicator	
	Animal LOEL (ug/kg)	Lifetime** Average Daily Exposure (ug/kg)	LOEL HERP	Lifetime*** Average Daily Exposure (ug/kg)	LOEL HERP
<i>Amitrole</i>	2,500	0.019	0.0008	0.077	0.0031
<i>Asulam</i>	750,000	0.024	0.000003	4.7	0.0006
<i>Atrazine</i>	3,500	0.039	0.001	12.	0.34
<i>Bromacil</i>	250,000	0.035	0.00001	15.	0.006
<i>2,4-D</i>	45,000	0.018	0.00004	4.7	0.01
<i>2,4-DP</i>	25,000	0.019	0.00008	4.9	0.02
<i>Dalapon</i>	N/A	0.044	—	15.	—
<i>Dicamba</i>	125,000	0.013	0.00001	0.96	0.0008
<i>Diuron</i>	*	0.054	—	15.	—
<i>Fosamine</i>	*	0.048	—	12.	—
<i>Glyphosate</i>	32,000	0.022	0.00007	5.9	0.02
<i>Hexazinone</i>	N/A	0.027	—	4.2	—
<i>Picloram</i>	380,000	0.011	0.000003	0.19	0.00005
<i>Simazine</i>	*	0.029	—	7.7	—
<i>Tebuthiuron</i>	N/A	0.022	—	5.9	—
<i>Triclopyr</i>	1,200– 30,000	0.032	0.003– 0.0001	7.7	0.64– 0.026

* = Not calculated due to inadequate data.

N/A = No positive rodent data.

** = Lifetime exposure for a "nearby resident" is represented by one routine-realistic exposure per year for 40 years plus one accidental exposure (routine-realistic and accidental exposures for residents are calculated in LAI – Appendix D).

*** = Lifetime exposure for a backpack sprayer is estimated by 15 routine-realistic exposures per year for a working life of 40 years (routine realistic backpack applicator exposure is calculated in LAI – Appendix D).

Summary of Potential Health Impacts by Exposure Scenario

Nearby Residents with Routine Spraying (Table IV–24)

Only Amitrole is in the uncertain confidence range for no adverse human health effect (for systemic effects) in this scenario. Atrazine and 2,4-D are in the moderate confidence range for all three types of toxic effects. Three others (Dicamba, Simazine and Triclopyr) are in the moderate confidence range for at least one toxic effect. Fosamine and Diuron had their confidence ranges estimated for only one effect each due to a lack of information on the other effects. The remaining eight herbicides are all in the high confidence range for no adverse human health effects.

Backpack Sprayers (Table IV–25)

Only Asulam and Picloram are in the high confidence range for no adverse human health effects for all three toxic effects in this scenario. Atrazine, 2,4-D, Simazine and Triclopyr are in the uncertain confidence range for all three types of toxic effects. The remaining herbicides are in the uncertain confidence range for at least one toxic effect.

Accidental Spraying—Worst Case (Table IV–26)

This scenario represents exposures that occur from one time accidental events. Although these events are unlikely to occur more than once to any one person, a significant number of complaints about herbicides involves exposures that fall under the heading of accidental.

All herbicides are in the uncertain confidence range for no adverse human effects for at least one toxic effect in this scenario. Six are in the uncertain confidence range for all three types of toxic effect. Two, Amitrole and Triclopyr, are in the very low confidence range for general toxic effects.

Lifetime Worst Case Exposures and Cancer Risks (Table IV–27)

This scenario represents worst case estimates of cancer risks from lifetime exposures to herbicides for workers and the public. Comparative cancer hazards—not actual estimates of risk—are presented using the LOEL HERP's described above. The higher the HERP, the higher the hazard. For additional information on Ames' HERP's and estimated HERP's for common daily risks, see Appendix H. In addition, Appendix D (LAI) contains estimates of actual risk based upon mathematical modeling.

Cancer hazard for applicators far exceeds the hazard for the public. The herbicides with comparatively high cancer hazard for applicators among these 16 herbicides are Atrazine and Triclopyr (with LOEL HERP's of 0.34 and 0.64 respectively). 2,4-D, 2,4-DP and glyphosate have moderately high cancer hazard (LOEL HERP's of 0.01, 0.02, and 0.02 respectively).

Amitrole

Amitrole has the lowest NOEL for systemic effects and the second lowest LOEL for carcinogenicity of all 16 herbicides evaluated. Both these effects have been consistent and repeated across various animal species. In addition, Amitrole has the lowest reproductive NOEL (estimated from the LOEL and based upon inadequate information) of the 16 herbicides. It has little potential for causing developmental toxicity. A non-significant positive association was reported between Amitrole exposure and lung cancer in one human epidemiologic study.

Amitrole is in the uncertain confidence range for no adverse human health effects in all three exposure scenarios. In the accidental scenario, it is in the very low confidence range for no effect, demonstrating an exposure greater than the animal NOEL (in this case, for systemic effects). Amitrole has a moderately low cancer hazard (LOEL HERP of 0.003) compared to the other 15 herbicides, due primarily to very low estimated exposures.

Asulam

Asulam has fairly low toxicity among these herbicides. It has shown some potential to cause cancer and reproductive toxicity, but at high dosage ranges. It also has some minor potential for neurotoxicity.

Asulam is in the moderate to high confidence range for no adverse human health effects in all scenarios. It is in the uncertain confidence range only in the accidental spraying scenario based upon systemic toxicity. It has a low cancer hazard (LOEL HERP of 0.0006) compared to the other 15 herbicides.

Atrazine

Atrazine has moderately high toxicity among these herbicides for systemic, reproductive and developmental effects and for carcinogenicity. It has moderate evidence supporting neurotoxicity.

Atrazine is in the moderate confidence range for no adverse human health effects for all three types of toxic effects in the public exposure scenario. However, it is in the uncertain confidence range for all toxic effects in the backpack and accidental spraying scenarios. Atrazine has a high cancer hazard (LOEL HERP of 0.34) compared to the other 15 herbicides.

Bromacil

Bromacil has moderate toxicity among these herbicides. It has the potential for carcinogenicity at high levels of exposure. Its ability to cause developmental toxicity is uncertain.

Summary by Herbicide

Bromacil is in the uncertain confidence range for no adverse human health effects in the backpack and accidental spraying scenarios, based upon systemic and developmental effects. It is in the high confidence range for all toxic effects in the public exposure scenario. Bromacil has a fairly low cancer hazard (LOEL HERP of 0.006) compared to the other 15 herbicides.

2,4-D

2,4-D has moderately high toxicity among these herbicides for systemic effects on the kidney, reproductive toxicity, and developmental toxicity. It has a low-level potential for cancer effects as indicated in animal studies. A moderate potential for producing neurotoxic and immunotoxic effects has been observed. Neurotoxic effects have been reported in human epidemiologic studies.

Phenoxy herbicides, a class of herbicides including 2,4-D, have been evaluated in a number of epidemiologic cancer studies in humans (summarized above). Some studies have shown highly significant associations with several rare cancers (Hodgkins and non-Hodgkins lymphomas and soft tissue sarcomas). Suggestive associations have also been established for lung and stomach cancer. The validity of these associations has been challenged, citing other studies that have not shown the same level of effect.

2,4-D is in the uncertain confidence range for no adverse human health effects in the backpack and accidental spraying scenarios, based upon systemic, developmental, and reproductive effects. In the public exposure scenario, it is in the moderate confidence range for all three toxic effects. 2,4-D has a moderate cancer hazard (LOEL HERP of 0.01) compared to the other 15 herbicides, based upon animal studies. The epidemiology data are suggestive of a carcinogenic effect at occupational exposure levels.

2,4-DP

2,4-DP has moderately high toxicity among these herbicides. Its systemic toxicity has been consistently observed. 2,4-DP has moderately high potential for carcinogenicity considering the animal data. In addition, as a phenoxy herbicide, the human cancer risks established with epidemiologic studies (summarized above) also apply.

2,4-DP is in the uncertain confidence range for no adverse human health effects in the backpack and accidental spraying scenarios. It is in the high confidence range for all toxic effects in the public exposure scenario. 2,4-DP has a moderate cancer hazard (LOEL HERP of 0.02) compared to the other 15 herbicides base upon animal studies. The epidemiology data are suggestive of a carcinogenic effect at occupational exposure levels.

Dalapon

Dalapon has moderate systemic toxicity and has some evidence for developmental toxicity. There is insufficient information on reproductive toxicity to make an evaluation. It is not considered a carcinogen.

Dalapon is in the uncertain confidence range for no adverse human health effects for systemic effects, and in the moderate confidence range for developmental effects in the backpack and accidental spraying scenarios. It is in the high confidence range for all toxic effects in the public exposure scenarios.

Dicamba

Dicamba studies conducted in animals have shown some evidence of developmental toxicity. It has carcinogenic potential, but at fairly high exposures. It has moderately high systemic toxicity among these herbicides, and a weak potential for neurotoxicity, both based upon inadequate data.

Dicamba is in the uncertain confidence range for no adverse human health effects in the backpack and accidental spraying scenarios, based upon developmental effects (it approaches the NOEL in the accidental spraying scenario). It is in the moderate to high confidence range in the public exposure scenario. Confidence ranges for systemic effects were not estimated for Dicamba, due to inadequate information (however, in the accidental spraying scenario, exposure exceeds the NOEL for systemic effects, based upon inadequate data). Dicamba has a low cancer hazard (LOEL HERP of 0.0008) compared to the other 15 herbicides.

Diuron

Diuron studies conducted in animals have shown some evidence of developmental toxicity. It has high systemic toxicity among these herbicides, based on inadequate data. A carcinogenic effect has not been observed in inadequate studies, and it has low reproductive toxicity, based upon inadequate data. Diuron has a weak potential for immunotoxicity, based upon inadequate data.

Diuron is in the uncertain confidence range for no adverse human health effects for developmental toxicity in the backpack and accidental spraying scenarios (exposures in these scenarios approach and exceed the NOEL for systemic effects based upon inadequate data). It is in the high confidence range for developmental toxicity in the public exposure scenario. All other confidence ranges and the cancer hazard were not estimated, due to a lack of information.

Fosamine

Fosamine has moderate toxicity for systemic effects. Significant levels

of developmental toxicity were observed in inadequate animal studies. It has low reproductive toxicity, based upon inadequate data, and no estimate was made of its carcinogenic potential.

Fosamine is in the uncertain confidence range for no adverse human health effects in the backpack and accidental spraying scenarios, and in the high confidence range in the public exposure scenario, all based upon systemic effects. All other confidence ranges and the cancer hazard were not estimated for Fosamine, due to insufficient information.

Glyphosate

Glyphosate has moderate toxicity among these herbicides. It has a low potential for carcinogenicity, and in animal studies has been shown to cause developmental toxicity.

Glyphosate is in the uncertain confidence range for no adverse human health effects in the backpack and accidental spraying scenarios, based upon reproductive and systemic effects. It is in the moderate confidence range for developmental effects in the same scenarios, and in the high confidence range for all three toxic effects in the public exposure scenario. Glyphosate has a moderate cancer hazard (LOEL HERP of 0.02) compared to the other 15 herbicides.

Hexazinone

Hexazinone has moderate toxicity among these herbicides. It has some potential for producing minor variations in animal development, but is not considered carcinogenic.

Hexazinone is in the uncertain confidence range for no adverse human health effects for systemic effects in the backpack and accidental scenarios. It is in the moderate confidence range for reproductive and developmental effects in the same scenarios, and in the high confidence range for all effects in the public exposure scenario.

Picloram

Picloram has moderate toxicity among these herbicides. It has a low carcinogenic potency and some potential for producing minor variations in development in animal studies.

Picloram is in the uncertain confidence range for no adverse human health effects in the accidental spraying scenario for systemic effects. It is in the moderate confidence range for reproductive and developmental effects in the same scenario, and for systemic effects in the backpack spraying scenario. All other effects in the various scenarios are in the high confidence range. Picloram has a very low cancer hazard (LOEL HERP of 0.00005) compared to the other 15 herbicides.

Simazine

Simazine has high toxicity among these herbicides for systemic and reproductive effects. It produced developmental effects only at doses 15 times greater than maternally toxic doses. There is insufficient information for evaluating carcinogenic potential. Simazine has a weak potential for neurotoxicity, based upon inadequate data.

Simazine is in the uncertain confidence range for no adverse human health effects for all effects in the backpack and accidental spraying scenarios. It is in the moderate confidence range for all effects in the public exposure scenario. The cancer hazard was not estimated for Simazine, due to inadequate information.

Tebuthiuron

Tebuthiuron has moderate toxicity among these herbicides and is not considered carcinogenic. It produced developmental toxicity only at doses 15 times greater than maternally toxic doses.

Tebuthiuron is in the uncertain confidence range for no adverse human health effects for all effects in the accidental spraying scenario, and for systemic and reproductive effects in the backpack spraying scenario. It is in the high confidence range for all effects in the public exposure scenario.

Triclopyr

Triclopyr has high toxicity among these herbicides, based upon systemic effects. In animal studies it has been shown to produce developmental effects at doses greater than maternally toxic doses. Reproductive studies were marginal, but some effects were observed. It has a moderate potential for carcinogenicity and minor developmental effects.

Triclopyr is in the uncertain confidence range for no adverse human health effects for all effects in the backpack spraying scenario, and for reproductive and developmental effects in the accidental spraying scenario. It is in the very low confidence range (with exposure exceeding the animal NOEL) for systemic effects in the accidental spraying scenario. It is in the moderate to high confidence ranges in the public exposure scenario. The estimated cancer hazard varies from high to moderate (LOEL HERP of 0.64 to 0.026) compared to the other 15 herbicides, based upon highly variable data.

Herbicides of Particular concern

The following five herbicides were judged to be of particular concern for toxicity.

Amitrole—based upon consistent systemic effects with a low NOEL

Summary

compared to the other herbicides, and an uncertain to very low confidence range for no adverse human health effects in the various scenarios. It also has a moderate cancer hazard (LOEL HERP of 0.003) compared to the other 15 herbicides.

Atrazine—based upon reproductive and systemic effects with low NOEL's compared to the other herbicides, and an uncertain confidence range for no adverse human health effects in the backpack spraying and accidental spraying scenarios. It also has a high cancer hazard (LOEL HERP of 0.34) compared to the other 15 herbicides.

2,4-D and 2,4-DP—based upon suggestive reproductive, developmental, and systemic effects with low NOEL's compared to the other herbicides, and uncertain confidence ranges for no adverse human health effects in the backpack spraying and accidental spraying scenarios. Also based upon human epidemiology demonstrating a carcinogenic potential and neurotoxicity at occupational exposure levels.

Dicamba—based upon a low NOEL for developmental effects compared to the other herbicides, and an uncertain confidence range for no adverse human health effects in the backpack spraying and accidental spraying scenarios for developmental effects.

Herbicides With Missing Information.

Two herbicides did not have sufficient information to evaluate:

Diuron

Fosamine

The Remaining Herbicides

The remaining nine herbicides all have some ratios in the uncertain confidence range for no adverse human health effects. It is recognized that the exposure scenarios are protective in that they should be overestimating typical exposures. This evaluation confirms the need to use appropriate precautions to make sure that actual exposures do not approach these estimates.

Inert Ingredients

Not considered in this characterization of risk for 16 herbicides are the formulations that are actually used in the field. These formulations may contain mixtures of the 16 active ingredients as well as other chemicals. These chemicals are used as carriers, or are designed to control droplet size, adhesion to target plants, and other desirable qualities.

Any chemical in a formula not added specifically to kill the target plant is called an inert ingredient. They are not necessarily chemically nor biologically inactive. It is very difficult to get a listing

of the “inerts” in any formulation because they are considered to be proprietary information. At this time, there is no regulation of inert ingredients.

The EPA has recently published a list of approximately 1,500 chemicals identified as inert ingredients from formulations submitted for registration. Fifty-five inert ingredients are on a short list of chemicals considered to be of “toxicological concern” to the EPA, and are high priority for regulatory action. These include chemicals previously identified as carcinogens, reproductive toxins, and neurotoxins. Asbestos, benzene, cadmium, carbon tetrachloride, formaldehyde, hexachlorophene, lead, pentachlorophenol, and trichloroethylene are some of the better known members of this group.

An additional 51 chemicals are on the second-priority list because they have chemical structures similar to known toxins. Again, the focus is on carcinogens, reproductive toxins, and neurotoxins. This list includes a large number of glycol ethers (members of this family of chemicals may be reproductive toxins), a number of phthalates (some of these are suspected carcinogens), cresol (a suspected carcinogen), methyl isobutyl ketone (a neurotoxin), and paraformaldehyde (which releases formaldehyde).

A third list names 300 “minimum risk inerts” which are not considered to have any toxic potential. However, included in this list is red-cedar chips. Western red-cedar dust may sensitize the respiratory tract of exposed workers.

The EPA did not have enough information to evaluate the inert ingredients not included in these three categories. This includes a number of alcohols, phenols, glycols, metallic zinc, epoxy resin, lead chromate, phthalic anhydride, aniline, and maleic anhydride. Some of these chemicals are sensitizers and could be considered quite toxic.

Interactions

Mixtures of chemicals may have substantially different toxicity than the sum of the types of toxic effects of the components. The chemicals may interact to increase toxicity (synergism), or to decrease toxicity (antagonism). Chemicals may have substantially different types of toxic effects when inhaled on particles than when exposed by other means.

There is little or no information available for evaluating the possibility that some of these 16 herbicides may interact with the inert ingredients to increase or decrease toxicity.

Impurities

Most tests utilize pure active ingredients for their experiments. These pure herbicides may not represent the true toxicity of technical grade

herbicides used commercially. In some cases contaminants, which may be only one percent or less of a technical grade herbicide, are considered more toxic than the pure product. Dioxin contamination of phenoxy herbicides is one example of this concern.

■ *Types of Human Health Effects*

Types of Health Effects

This EIS requires the comparative evaluation of human health effects associated with various alternatives. The comparison is difficult due to the different forms that health effects can take.

Some health effects are immediate and obvious. These are usually called "acute health effects." Others may require repeated exposures over a period of months or years, and may take considerable time before becoming apparent. These are called "chronic health effects." Chronic health effects may blend into the general health problems of life and never be detected.

Sometimes the fear of possible health effects might have stronger impacts upon the health of an individual than the actual exposure. These perceived health risks might have serious impacts upon the health of the individual by inducing stress, worry, or concern.

Each of these health effects is measured differently. Acute effects are often reported and logged. These logs can be retrieved, evaluated, and summed. The total number of reported effects can then be evaluated in terms of some meaningful category such as person-hours at risk for the acute exposure.

Chronic effects are generally not logged. They are frequently not recognized as being associated with any particular exposure. Even if the association is made, the individual may no longer be at the same job site or residence when the effects become apparent.

For these reasons, chronic effects are usually studied after the fact in epidemiologic studies. They may also be predicted by animal studies. Each type of study requires its own assumptions about how its results can be applied to the situation being evaluated. These methods are not nearly as exact as counting incidents in a log book.

Measuring the impact of perceived health risks is even more difficult. However, it is clear that there is a high level of public concern, demonstrated by the large volume of public comments focused on the possible health effects of herbicides and fire smoke.

Apportioning Risk

Most activities involve both risks and benefits. The major problem in determining a trade-off between the risks and benefits is that they do not necessarily fall to the same individuals or groups.

In 1970, Congress passed the Occupational Safety and Health Act. The act was designed to assure that no worker would have to decide between the benefits of employment and the preventable risks of the job. Nevertheless, workers will frequently accept some risk for a job they want or need.

This balance between benefit and risk breaks down when a group perceives a risk, but no benefit. It is the perception of risks and benefits that is important. This perception may or may not reflect the actual situation.

Thus, the question of perceived health risks is of major importance in public acceptance of Forest Service policies.

Public involvement in risk associated with vegetation management is generally limited to off-site effects of Forest Service activities. The activities that have obvious potential for producing off-site effects are fire (through smoke) and herbicides (primarily through aerial spraying). There are less obvious risks—such as from increased soil compaction—which could affect water supplies.

In the case of herbicides and smoke, it should be obvious that routine exposures to the public are much smaller than worker exposures. Dilution of smoke and herbicides is usually rapid. In addition, workers are usually exposed repeatedly as they move from one site to another. Members of the public will seldom be exposed to herbicides (if available), because less than two-tenths of one percent of Forest lands would be treated with them annually.

Accidental exposures may be of greater concern to the public. Accidents may involve exposures that are high, even for workers. However, such exposures also are not likely to occur more than once to any individual.

Thus, while risk cannot be completely eliminated, the risk to the general public should be considerably less than that to workers.

■ ***Comparison of Human Health Risks Associated with Various Methods of Vegetation Management***

Five herbicides (Amitrole, Atrazine, 2,4-D, 2,4-DP, and Dicamba) have sufficiently high levels of uncertainty about human health effects at exposure levels estimated for backpack sprayers to cause concern. This concern extends to mixer-loaders and pilots in aerial applications who are estimated to have 10 to 25 percent of the backpack sprayer exposure. Based upon assumptions designed to minimize health risks,

Public Involvement in Risk

Risks Associated with Herbicide Methods

these five herbicides also have uncertain health impact for some public exposures.

Two additional herbicides (Diuron and Fosamine) have insufficient data to determine their potential toxicity. The remaining herbicides considered in this risk characterization have various areas of moderate to high impact potential, and should be evaluated for particular applications.

Risks from exposures to inert ingredients in herbicides and to contaminants, and from possible interactions between mixtures of herbicides, remain unevaluated. Risks from exposure to inert ingredients may be reduced by not using any formulated herbicide containing inert ingredients on the two highest priority lists established by the EPA.

Risks From Prescribed Fire Methods

The risks from prescribed fire methods of vegetation management have not been widely studied. While smoke dispersion models exist, there has been no generally accepted application of these models to forest fires, and fire emissions have not been fully characterized. However, an assessment of their impact was made by Newton and Dost (1984), and again by Dost (1986).

Risks From Accidents

Newton and Dost present data gathered from the Siuslaw and Wenatchee National Forests, and from two forest industries operating in northwest Oregon. The data covered between one and three years from these sources, and included acute injuries only. No fatalities were reported. A total of 14 minor injuries and one disabling injury was reported. These averaged out to one minor injury for every 500 acres treated with prescribed fire, and one disabling injury for every 7,500 acres. According to the authors, data from the Oregon State Accident Insurance Fund (SAIF) showed similar frequencies for injuries between 1980-83.

The evaluation of health effects due to exposure to fire smoke requires 1) an inventory of the various components of fire smoke and an estimation of the volumes of each component produced by fires; 2) a model of how these components disperse and distribute to populated areas; and 3) an estimation of the individual and combined health effects of these components.

Risks from Smoke

The various components of forest fire smoke have been fairly well characterized, but the quantity produced varies considerably due to factors such as fuel moisture and fire temperature (Oregon DEQ 1987a). The various components include, among others, polycyclic aromatic hydrocarbons (PAH), benzo-a-pyrene (BaP), dioxins, formal-

dehyde, acetaldehyde, phenol, and manganese (Radian Corp. 1985). Carbon monoxide, carbon dioxide, and oxides of nitrogen are also generated.

It is also important to note what is not in fire smoke. In particular, sulfur oxides and sulfates are not generated in important amounts by vegetation fires. These are, however, major components of smoke generated by burning coal or fossil fuels (e.g., auto exhaust). Almost all investigations of the toxicity of particulate matter in human populations have been conducted with particulates associated with these types of fuels.

The vast majority of particulate matter generated by forest fires is thought to be in the fine particulate (FP) range: 90 percent is less than 2.5 microns in diameter (Oregon DEQ 1987b). This is of considerable importance, since these small particulates can be inhaled deeply into the lungs and deposit there. Estimates of the number of pounds of total PAH, BaP, and acetaldehyde produced by forestry slash burning and wildfires in Oregon during 1985 are listed in Table IV-28 (Oregon DEQ 1987a).

Table IV-28

Oregon 1985 Fire Emissions Estimates

	PAH (lbs)	BaP (lbs)	Acetaldehyde (lbs)
Slash Burning:	18,323	529	14,866,559
Wildfires:	1,042	42	3,300,560

Estimation of the distribution of toxins from fire smoke involves determining drift, dilution and breakdown of the components.

The gaseous components will generally decompose or be diluted quite quickly (Dost 1986). However, some of these components, such as the aldehydes, may attach themselves to the particulates formed, and thus remain more concentrated and possibly protected from decomposition (Dost 1986). Partly for these reasons, exposures to smoke have generally been estimated by measuring particulate concentrations in the air. This would not necessarily be a good estimate for people in close contact with fire smoke, such as some Forest Service workers.

While some smoke dispersion models do exist, there has been no generally accepted application of these models to smoke dispersion of forest fires. However, direct measurements of air concentrations of particulate matter have been made in communities located close to

The Components of Fire Smoke

Distribution of Smoke and Estimated Public Exposures

areas of forest slash burns (Oregon DEQ 1986). Five locations were sampled in 1985, based upon proximity and wind direction (down-wind) from areas with field and slash burning.

Total suspended particulates (TSP) and particulates under 10 microns (PM-10) were measured (Oregon DEQ 1986). The highest 24-hour average TSP measurement was 83 micrograms per cubic meter (ug/m^3). The highest 24-hour average PM-10 measurement was $60 \text{ ug}/\text{m}^3$. These studies represent estimates of the maximum impact of slash burning upon air quality over population centers.

Exposures for Forest Service workers managing prescribed fires or fighting wildfires would be much greater than these exposures. No direct measurements of these exposures have been made.

Toxic Effects of Fire Smoke

Toxic effects of smoke have primarily been estimated by associations of morbidity and mortality with exposures to particulate matter. However, individual components of fire smoke have also been evaluated.

Some components, such as many PAH, are carcinogenic. Probably the most toxic is PaB. It has been demonstrated that BaP increases in potency when mixed with carbon particulates (Dost 1986). An estimate of cancer risks due to PAH from smoke inhalation was made by Dost (1986), using EPA's estimate of carcinogenic potency for BaP (a 0.0033 excess lifetime risk for cancer from a continuous exposure to one microgram per cubic meter) and assumed exposure levels for the public. His upper estimate of risk was in the range of one additional cancer per million people exposed.

Other components of fire smoke are acute irritants (such as the aldehydes). While these are most likely to affect forest workers receiving high exposures, they may have some effect with lower level exposures.

The majority of information on the possible effects of exposure to fire smoke come from associations between TSP and fine particulate (less than 2.5 microns in diameter) concentrations and the morbidity and mortality statistics. Consistent associations between air quality as measured by TSP or FP and morbidity and mortality have been demonstrated.

Some reviewers have stated that increased mortality is associated with 24-hour airborne particulate matter concentrations (TSP) as low as $140 \text{ ug}/\text{m}^3$, with re-evaluation of the data suggesting associations at possibly lower concentrations (California Air Resources Board 1981). Chronic health effects have reported associations with 24-hour levels as low as $77 \text{ ug}/\text{m}^3$ (California Air Resources Board 1981). Another review suggested that chronic effects may be associated with 24-hour air concentrations of intermediate particulates (less than 15

microns in diameter) below 60 ug/m^3 (OMNI 1987, pg. 18).

One of the major problems with using these human epidemiologic studies to evaluate the effects of fire smoke is the different composition of the air pollutants studied. Most of these studies have been carried out in urban areas with considerable particulate concentrations from automobile and industrial combustion of gasoline, diesel, oil, and coal. All these sources include various metals, sulfates, and other components not found in fire smoke.

Varying composition is complicated by demonstrated interaction between the components of various air pollutants. For example, human clinical studies have demonstrated that combining sulfur dioxide with an aerosol of table salt increases the toxicity of the sulfur dioxide (California Air Resources Board 1981, pg. 103). Such interactions make it difficult to evaluate the toxic effects of the separate components of air pollution.

An ongoing evaluation of the health effects of particulate matter is being conducted at Harvard University (Ozkaynak et al. 1986). This group has reviewed and refined information from various cities and has proposed the following conclusions:

- 1) the highest risk with city air pollutants is associated with levels of sulfates;
 - 2) the next highest risk is associated with levels of FP, with larger particulates having only minor toxic effects;
 - 3) the toxicity of air pollution is dependent upon the source.
- Among the sources studied (soil, auto, oil, metals industry, and coal combustion), the metals industry and coal combustion were the most toxic, and soil was the least toxic (Ozkaynak et al. 1986). Fire smoke was not included in the sources studied.

Air pollution has been clearly associated with mortality and morbidity. However, the health effects of air pollution due to slash burning and wildfires has not been directly studied.

The highest levels of total suspended particulates (TSP) associated with slash burning observed in Oregon were 83 ug/m^3 . This level slightly exceeds the lowest estimated concentrations for intermediate particulates (IP) associated with chronic effects. The IP measurement is more restrictive than TSP, and thus the TSP overestimates the particulate concentration when compared to IP.

Thus, the highest level of particulate air pollution measured in Oregon approximately equals the lowest level of particulate air pollution at which observed chronic effects have been reported. This level does not necessarily reflect a no effect level. There is no evidence available to establish a no effect threshold for fire smoke.

Our confidence that no adverse human health effects will occur

due to exposure to fire smoke at levels reaching population centers is uncertain. It is not possible at this time to quantify expected impacts. Observed particulate levels suggest that prescribed fire will not cause particulate levels to exceed the PM-10 standard (150 ug/m³) proposed by the Environmental Protection Agency (Oregon DEQ 1986).

Exposures to forest workers managing or fighting fires are likely to exceed levels with demonstrated health effects. Thus, the degree of confidence that no health effect would occur among these workers is very low.

Risks From Mechanical Methods

The risks from mechanical methods of vegetation management have not been widely studied. However, an assessment of their impact was made by Newton and Dost (1984). These estimates are for accident risks.

The most serious accidents associated with mechanical clearing is when machinery rolls. Other risks are associated with rolling or snapping vegetation. According to the authors, only four accidents associated with mechanical clearing were reported to SAIF in 1979. The accidents were apparently not too severe as they averaged less than \$300 per claim. There was no acreage base available for these accidents.

From these data it can be assumed that, while accidents are a possibility with mechanical methods, both major and minor accidents are rare.

Risks From Manual Methods

The risks from manual methods of vegetation management have not been widely studied. However, an assessment of their impact was made by Newton and Dost (1984).

Newton and Dost discussed two small observations of forestry crews. One reported one minor injury per 13 person-days of brushing, based upon 265 person-days. Another reported only one minor accident in 30 person-days of brushing.

Data from SAIF covering only brushing activities were reported by the authors. From 1978-79 there were 55 claims averaging about \$2,000. Four were above \$9,000. Similar figures were shown for 1980-83, but were more difficult to interpret as major companies started to self-insure. The figures from SAIF include private companies which may not practice the same work safety procedures as the Forest Service.

The authors also reported that from 1980-83 there were 89 accidents involving chain saws in reforestation activities, but they could not determine how many of these were due to brushing. The average cost of these claims was \$374. The authors concluded that the "major injuries are largely the result of the environment in which

workers are operating, and that there is an overlay of relatively minor injuries resulting from the use of saws" (p. 367). The major injuries involve bruises, broken bones, and sprains.

Newton and Dost, using data from SAIF and estimates of the number of acres of Oregon forests cleared annually by manual methods for 1978-83, calculated that one accident occurs for every 130 acres cleared manually (per 438 person-days of work). This estimate will be used for this EIS.

The risks from biological methods of vegetation management have not been widely studied. One study was conducted by Oregon State University (Peterson 1983). This study looked at fecal coliform contamination of streams on land being intensively grazed by sheep in the Alsea Ranger District.

The results of the study showed generally small increases (with a few large increases) in fecal coliform concentrations after grazing. All levels were well below state water quality standards. Nevertheless, the Forest Service felt that mitigation methods such as restricting watering areas for the sheep would be important. The increased risk from grazing is considered quite low.

Risks From Biological Methods

■ *Comparison of Risk Among Alternatives*

Table IV-29 shows the changes in acres treated (x1,000) by each method for the seven alternatives, using Alternative B as the baseline. It is followed by a description of expected changes in health effects for each alternative.

Table IV-29

Thousands of Acres Treated Yearly by Method and Alternative
(Compared to Alternative B)

Alternative:	A	B	C	D	E	F	G
<i>Method</i>							
Herbicide	-60	0	-60	-33	-12	+4	+17
Fire	+8	0	-210	-84	-16	-34	+5
Mechanical	+18	0	-122	-55	0	+34	-11
Manual	+21	0	-60	-20	+17	+2	+8
Biological	+11	0	0	+15	+2	+4	+3
Total:	-37	0	-504	-213	-36	-90	+35

Alternative A:

This alternative prohibits the use of herbicides. It has a large decrease in acres treated with herbicides and smaller increases in prescribed fire, manual, mechanical, and biological methods. Some problems with adverse health effects from noxious weeds may occur.

Herbicide—the elimination of the use of herbicides will reduce the potential for chronic toxicity. There will be a substantial positive impact on public perception of risk.

Fire—the increase in acres treated with fire could result in approximately 16 injuries, primarily minor.

Mechanical—the increase in acres treated by mechanical methods is negligible.

Manual—the increase of 21,000 acres treated could result in approximately 162 injuries, primarily minor.

Biological—the increase in acres treated would result in minimal excess risk.

Overall—reduced potential chronic toxicity and perceived risk; an estimated increase of 178 minor injuries.

Alternative B:

This is the baseline alternative. Historical risk pattern would prevail for herbicide, prescribed fire, mechanical, manual, and biologic methods. There would likely be ongoing problems with public perception of risk.

Alternative C:

This is the “no action” alternative. There is a drastic reduction in all methods. Some increases in risk due to noxious weeds or physical hindrances of unwanted vegetation are expected.

All methods—health risks would be markedly reduced.

Alternative D:

This alternative stresses prevention and restricts efforts to control vegetation to areas where adverse effects of the vegetation are fairly certain. All methods other than biological are reduced. Health risks from noxious weeds and unwanted vegetation are not increased.

Herbicide—the reduction in the use of herbicides will reduce the potential for chronic toxicity. There will be a substantial positive impact on public perception of risk.

Fire—the reduction of 84,000 acres treated with fire is significant, causing an estimated reduction of 170 minor injuries and about a dozen disabling injuries. Potential chronic health effects would also be reduced.

Mechanical—the decrease in acres treated is significant, but

will probably have a minimal impact on risk.

Manual—the decrease of 20,000 acres treated could result in a reduction of approximately 160 injuries, primarily minor.

Biological—the increase in acres treated would result in minimal excess risk.

Overall—major reductions in both accidents and potential chronic toxicity. An estimated 330 less minor accidents and 12 less disabling injuries. Perceived risk on the part of the public would be greatly reduced.

Alternative E:

This alternative restricts all aerial spraying. All methods except manual and biological are reduced or remain the same. Health risks from noxious weeds and unwanted vegetation are not increased.

Herbicide—the reduction in the use of herbicides will not necessarily reduce the potential for chronic toxicity because there will be considerably more backpack spraying. There will, however, be a substantial positive impact on public perception of risk.

Fire—the reduction in acres treated with fire is moderate, resulting in an estimated reduction of 32 minor injuries and a couple of disabling injuries. Potential chronic health effects would also be reduced.

Mechanical—no change.

Manual—the decrease of 17,000 acres treated could result in a reduction of approximately 130 injuries, primarily minor.

Biological—the minor increase in acres treated would result in minimal excess risk.

Overall—moderate reductions in both accidents with an estimated reduction of 152 minor injuries and two disabling injuries. Potential chronic toxicity is probably unchanged. There will, however, be a substantial positive impact on public perception of risk.

Alternative F:

This alternative restricts the use of prescribed fire methods. The use of fire is reduced considerably, while herbicide use is only slightly increased. Use of manual methods increases slightly, while mechanical methods increase considerably. Biological methods are slightly increased. Health risks from noxious weeds and unwanted vegetation are not increased.

Herbicide—the small increase in the use of herbicides will be negligible.

Fire—the reduction of 34,000 acres treated with fire is significant, causing a reduction of approximately 68 minor injuries and four disabling injuries. Potential chronic health effects will also be reduced.

There will be some positive impact on public perception of risk.

Mechanical—there is a significant increase in acres treated, resulting in an estimated single extra injury.

Manual—the increase of 2,000 acres treated could result in an estimated increase of approximately 15 injuries, primarily minor.

Biological—the increase in acres treated would result in minimal excess risk.

Overall—there would be an estimated decrease of about 53 minor accidents and four disabling injuries. Some reduction in potential chronic health effects would be expected. There will be some positive impact on public perception of risk.

Alternative G:

This alternative calls for increased intensive management of the Forests. Primarily herbicide methods are increased, with smaller increases in most other methods. Mechanical methods have a moderate decrease.

Herbicide—the moderate increase in the use of herbicides would increase the potential for chronic toxicity. There would be an adverse effect on the public perception of risk.

Fire—the increase of 5,000 acres treated with fire would result in an estimated increase of 10 minor injuries and one disabling injury. Potential chronic health effects would be slightly increased.

Mechanical—the decrease in acres treated is moderate, but will have a minimal impact on risk.

Manual—the increases of 8,000 acres treated could result in an estimated increase of approximately 62 injuries, primarily minor.

Biological—there is a small increase in acres treated, with minimal impact on risk.

Overall—there would be an estimated increase of 72 minor injuries and one disabling injury. There would be a moderate increase in potential chronic toxicity. There would be a substantial adverse effect on the public perception of risk.

Chapter 4

Environmental Consequences

- Costs
and Benefits
- National
Forest
Budgets
- Social and
Economic
Effects
- Productivity
- Unavoidable
Adverse
Effects
- Commitments
of Resources

Costs and Benefits

The costs and the benefits of managing vegetation are a very important management concern, and an important management implication of the different alternatives. Costs and benefits are presented in this EIS using the "present net value" calculation. It is presented in the section comparing alternatives in Chapter II. Additional information about the data and analyses of costs and benefits are presented in Appendix B.

National Forest Budgets

The alternatives under consideration do not all indicate the same level of management on the National Forests. In some alternatives, output levels might remain virtually unchanged, but costs would go up. The net effect of these differences by alternative is shown in the section comparing alternatives in Chapter II. Forest budget costs are included in the analysis of the effects on the economy.

Social and Economic Effects

Changes in the national demand for forest products will continue to produce changes in local employment patterns (especially in Oregon, with its greater dependency on natural resources and greater National Forest acreage and outputs). Variations in vegetation management practices will have an influence far smaller than that of many other external factors that influence the market for these commodities.

For any alternative but Alternative C, the level of national economic activity, new housing, and consumer optimism have more of an impact on the region's economy and on resource-dependent communities than does variation in vegetation management.

Communities and people in the Region are, and will continue to be, affected by vegetation management on the National Forests. However, those effects are relatively small when viewed against the backdrop of the effects caused by the nation's economy.

For all alternatives, these trends, plus short-term conditions such as interest and employment rates and international trade agreements, have wide-ranging effects of much greater magnitude than the changes considered here (except for Alternative C).

The Effect of National Changes

The Effect of Local Changes

In addition to the large-scale changes overshadowing the effects estimated here, there may be significant project-level decisions which will have economic and social effects. Project-level decisions may have important effects which can not be analyzed critically at this Regional level of analysis. The effects which can be discussed are those aggregated across the entire Region. Local effects may be different from, or counter to, the effects estimated for the Region as a whole. Project-level environmental analyses will analyze and disclose those consequences.

Economic Effects of the Alternatives

Although the management of unwanted and competing vegetation is a small part of the total level of activity on National Forests in the Region, it has important implications for the communities within Oregon and Washington.

The principal avenue of those effects is the economy. Changes in the management of unwanted vegetation change the work that is done on the National Forests, and change the amount of commodities that the Forests can be expected to produce.

The principal measures of annual regional economic effects used here are: changes in jobs; changes in personal income; and changes in payments to local governments.

The changes in the total number of jobs and in the total amount of personal income received by people is estimated using the IMPLAN input-output model. This model and the analysis process are described in the economic analysis appendix.

The jobs and personal income estimated are not just the jobs and personal income directly tied to vegetation management, or even just those jobs directly tied to forestry and forest products. All the jobs and income that are created, as money from them moves through the economy, are included in these figures.

In estimating the effects on employment and personal income, three principal sources of change were identified. They are: the amount of permitted livestock grazing; the Forest Service budget; and the amount of timber offered for harvest. Table IV-30 shows the effects of the alternatives on job opportunities in the Pacific Northwest.

Changes in total annual personal income reflect this same pattern, as shown in Table IV-31.

A share (usually 25 percent) of gross National Forest receipts is sent to local governments. The money is used to support local roads and schools. Estimate as to how these payments would be affected by the alternatives are shown in Table IV-32.

Effects on Communities

The economic effects of the alternatives, except for Alternative C, appear relatively small within the context of the entire two-state economy. However, the economic effects tend to be concentrated in

Table IV-30

Changes In Numbers of Jobs In Oregon and Washington¹

Alternative A	-1,100	-0.04% of Total Employment
Alternative B	Reference*	Total Employment = 2,827,000 ²
Alternative C	-21,800	-0.77% of Total Employment
Alternative D	-3,100	-0.11% of Total Employment
Alternative E	-1,400	-0.05% of Total Employment
Alternative F	-3,100	-0.11% of Total Employment
Alternative G	+2,600	+0.09% of Total Employment

* The reference is the expected situation during the first decade of implementation of the Forest Plans currently being developed.

¹ Information was generated using the IMPLAN local economic impact model described in Appendix B. "Jobs" includes permanent and temporary positions, part-time and full-time positions, without discrimination. Figures shown represent average annual conditions over the coming decade.

² See Chapter III, Social and Economic Conditions.

Table IV-31

Changes In Average Annual Personal Income in Oregon and Washington¹

Alternative A	- \$ 28,200,000
Alternative B	Reference*
Alternative C	- \$533,300,000
Alternative D	- \$ 75,800,000
Alternative E	- \$ 33,000,000
Alternative F	- \$ 74,800,000
Alternative G	+ \$ 62,800,000

* The reference is the expected situation during the first decade of implementation of the Forest Plans currently being developed.

¹ Information was generated using the IMPLAN local economic impact model described in Appendix B. Figures shown represent average annual conditions over the coming decade.

rural areas. The rural areas of the two states have the least diversified economies, generally the highest unemployment levels, and the lowest income levels. Their tax bases are small, and they often depend on returns from Forest Service receipts for a significant part of their budgets.

The social changes stemming from changes in the economic vitality of local communities are well documented. Indicators of economic hard times and uncertainty include increased rates of alcoholism, child abuse, family stress, and the decline of local organizations and services.

Table IV-32

Changes in Annual Payments to Local Governments¹

Alternative A	– \$ 4,900,000
Alternative B	Reference*
Alternative C	– \$57,100,000
Alternative D	– \$ 7,400,000
Alternative E	– \$ 4,300,000
Alternative F	– \$ 8,400,000
Alternative G	+ \$ 2,600,000

* The reference is the expected situation during the first decade of implementation of the Forest Plans currently being developed.

¹ Information was generated using the IMPLAN local economic impact model described in Appendix B. Figures shown represent average annual conditions over the coming decade.

However, the rates of economic change seen in the alternatives, except for Alternative C, are well within the usual year-to-year variation in employment, income, and payments seen in the Pacific Northwest.

Thus, while the community effects of Alternatives A, D, E, and F are not positive ones, they are, on average, significantly less disruptive than recently experienced changes in the region's communities.

Alternative G does contribute positively through slightly enhanced economic activity, but this change is again minor compared to the normal changes of season and business cycle. Alternative C does significantly disrupt normal economic activity in the region, and would have corresponding disruptive effects on Pacific Northwest communities.

The economic downturn associated with Alternative C would have major effects on timber-dependent economies and communities in the Northwest. There it would have secondary health effects on families and communities. The emotional strain of unemployment is manifested in child and spouse abuse, alcoholism, and stress-related diseases (Weeks, 1982).

Other Social Effects

In addition to the social and community effects that derive from the changes in the local economy, there are social results that come from the decision and the implemented program itself. These include the nature and degree of social conflict the decision and program generate, and perceptions of the safety and productivity of the National Forests.

It is beyond the scope of this EIS and the available data to estimate these effects from a Region-wide perspective. However, these effects are most likely to be seen in rural areas and small towns near

the National Forests. Increased awareness of vegetation management activities; increased risk of exposure to tool and chemical accidents; and greater personal and community dependence on forest settings and forest products all draw rural attention to vegetation management policies and practices.

These are dimensions that should be considered in the project-level design and its site-specific environmental analysis. Appropriate public contact and participation will greatly mitigate these possibly negative social effects.

The effects on civil rights, including those of minorities and women, is expected to be minimal and not systematic. These will be analyzed in the site-specific environmental analyses and project designs.

Dimensions of special concern include possible damage to sites and plants used in American Indian religious practices; and the safety of field workers using manual, prescribed fire, or backpack methods (as racial and cultural minority groups may be prevalent in these work forces).

The overall economic effects of the alternatives will not affect minority group members in any unique way.

Effects on Minorities

Short-Term Use Versus Long-Term Productivity

“Short-term” uses are generally those that determine the present quality of life for the public. Short-term uses of Forests in the Pacific Northwest Region typically include timber harvest, recreation, livestock grazing, transportation, utility corridors, and wildlife habitat. Decisions about these short-term uses are made through the National Forests Land and Resource Management Plan.

Compared to all of the activities that take place in a Forest, a relatively narrow spectrum of management activities is considered in this EIS. Managing competing and unwanted vegetation helps provide the flow of goods and services associated with the short-term uses of a Forest. The process presented here for managing vegetation—and many of the mitigation measures—are designed to protect the long-term productivity of the land.

“Long-term productivity” refers to the capability of the land to support sound ecosystems producing resources such as forage, timber, wildlife, and water. Management activities associated with short-term uses (for example burning, use of machinery, or removal of woody debris) may reduce the natural productivity of some portions of the

National Forests. How much the long-term productivity is reduced is not known because investigations of these effects have only recently begun.

The herbicides examined in the EIS have no long-term effect on long-term productivity. However, it is known that any management activities have the potential to reduce the natural productivity of the land if certain operating guidelines are not followed. Each Forest Plan is developing management standards and guidelines designed specifically to protect long-term productivity. In addition, mitigation measures were developed for those management activities considered in this EIS.

Alternatives A, B, E, and F all have the same potential effect on long-term productivity. While difficult to compare to historic conditions, the predicted prevention of severe wildfires in these alternatives will enhance productivity from earlier times. Other practices will somewhat reduce the potential productivity on some specific sites.

Alternative G will cause a slight reduction in long-term productivity due to less biomass nutrient cycling (because of removal or burning of most logging slash). Alternative C will have a greater adverse effect because of the greater risk of extensive and severe wildfires resulting in soil and plant damage. Alternative D will have a slight positive effect on long-term productivity, as it will leave plant material on sites, making more nutrients available for cycling.

Unavoidable Adverse Effects

Implementation of any alternative would result in some adverse environmental effects that cannot be avoided. Standards and guidelines from Forest Plans—and mitigating measures developed in this EIS—are intended to keep the extent and duration of these effects within acceptable levels, but adverse effects cannot be completely eliminated.

Because this EIS examines alternative programs for managing competing and unwanted vegetation, including slash, the focus is on how a series of projects conducted over a period of years could affect the environment. From this perspective, there are three areas of potentially significant adverse effects:

- human health risks;
- degradation of air quality from fires; and
- economic effects.

The potential for adverse effect varies with each alternative, and is discussed in detail in this EIS.

Human health risks exist for both workers and the public. Risks that workers face from vegetation management activities that were considered in this EIS include:

- accidents from manual control of vegetation;
- accidents from prescribed burning and wildfire suppression;
- exposure to smoke; and
- exposure to herbicides.

Two groups—forest workers and the public—face exposure to herbicides and fire smoke (see Figure IV-11). Worker exposures are far greater in quantity and duration for both herbicides and smoke, which is why these risks (as a group) are roughly equivalent to the risk to the rest of those affected (the public). Two alternatives have significantly less risk for both groups. Alternative C has the least risk, and Alternative D has the next least risk.

The members of the public who experience risks from herbicides are those who come in direct contact with herbicides. Potential routes of exposure are discussed in the EIS in detail. More numerous are the members of the public who experience exposure to smoke from prescribed fires or wildfires.

Health risks to the public at large are roughly correlated with overall level of management activity, as are the levels of economic

Figure IV-11

Index for Risks

To Workers and the Public for Exposures to Herbicides and Fire Smoke by Alternative

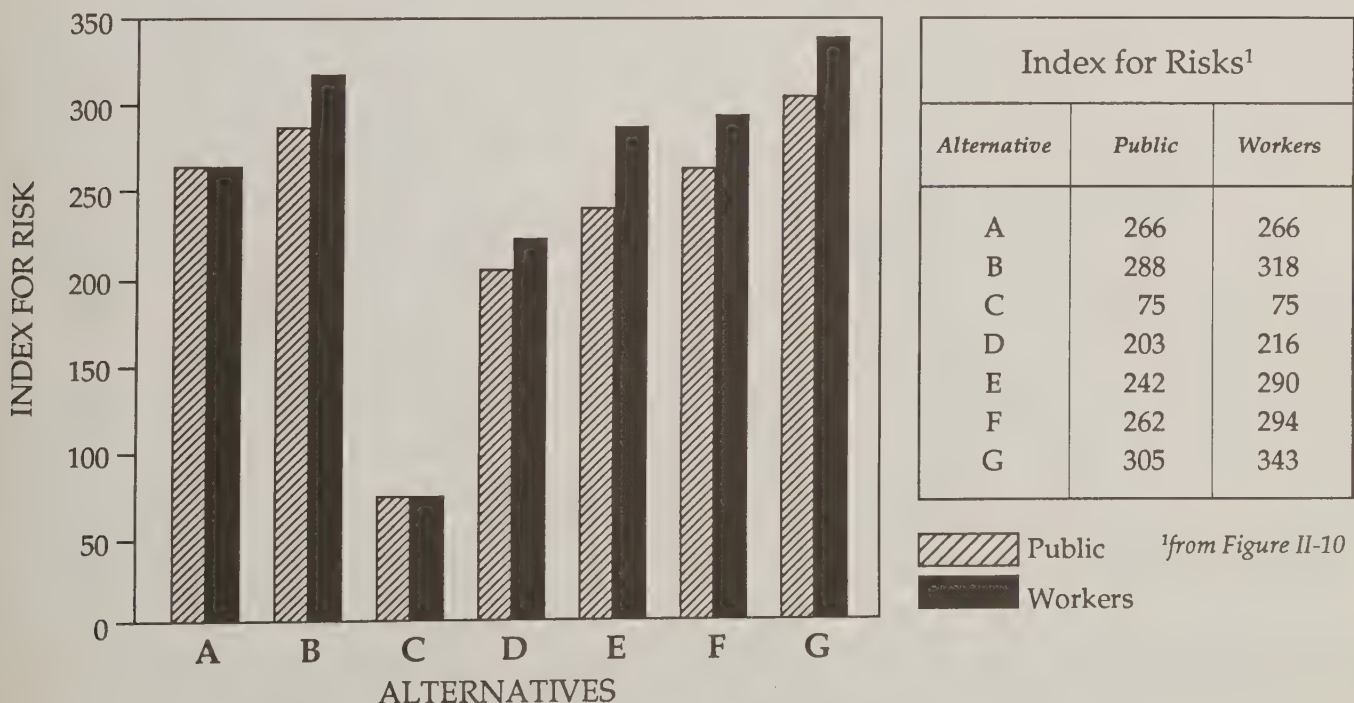


Figure IV-12

Comparison of Benefits to Public Risk From Exposure to Herbicides and Fire Smoke

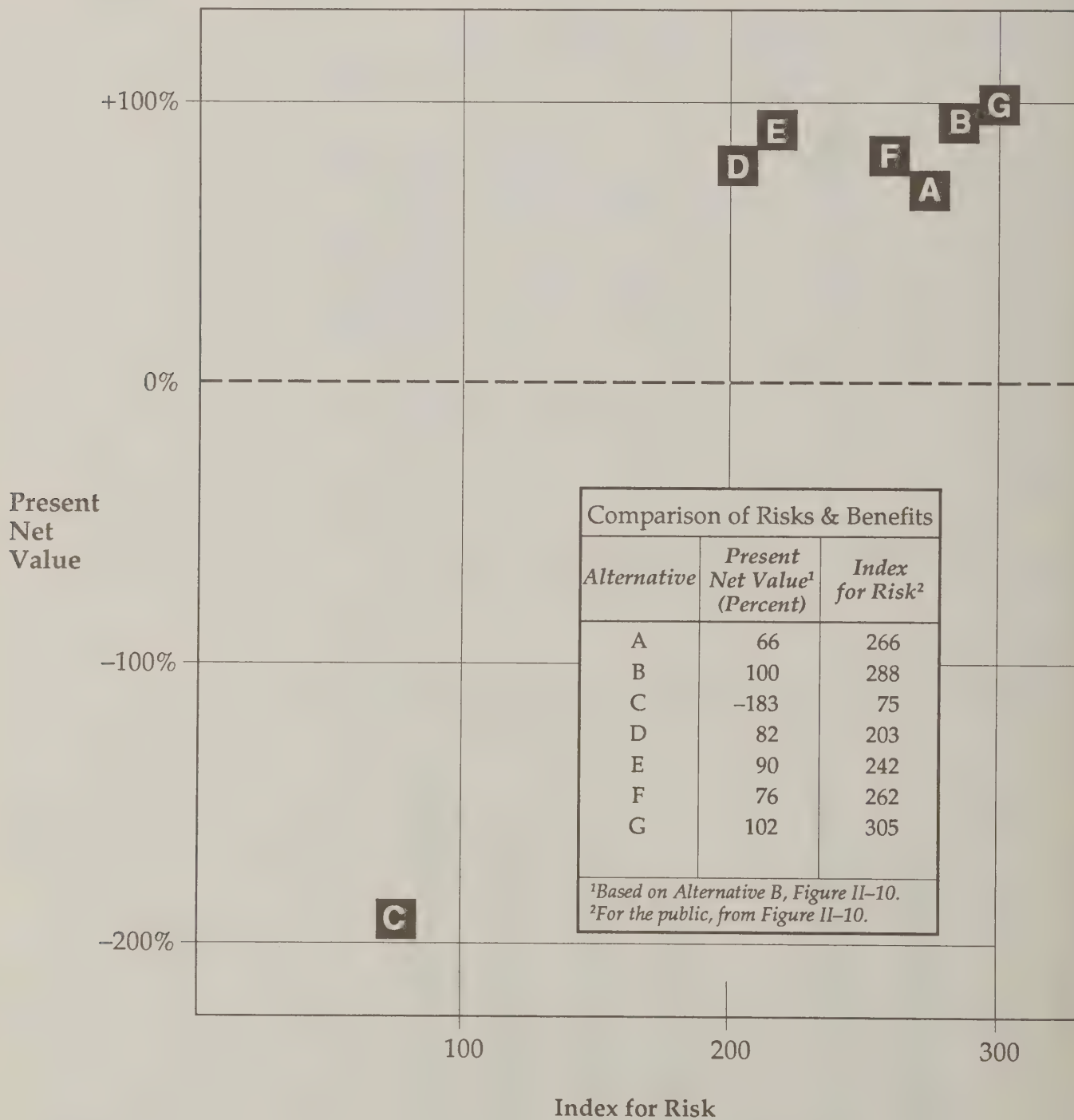
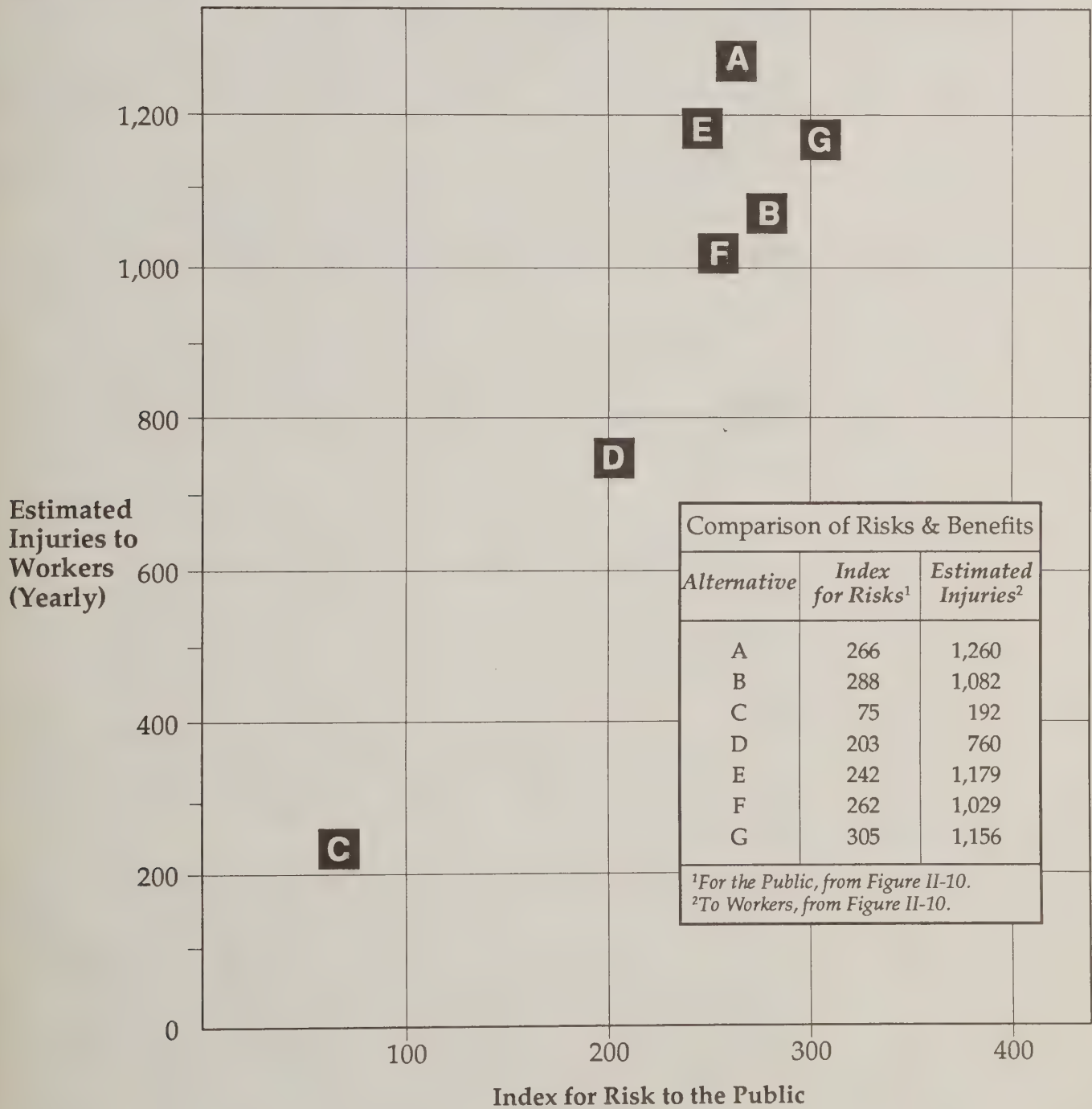


Figure IV-13

Comparison of Worker Injuries to Public Risk From Exposure to Herbicides and Fire Smoke



product and efficiency. Figure IV-12 shows the relationship of risks to net dollar-measurable benefits. Alternative C has the least risk, and also has very low present net value (PNV). Alternative D has the next least risk, with much higher present net value.

Alternatives E, B, and G (respectively) yield incremental increases in present net value, for additional increments of risk. Alternatives F and A pose relatively higher risks than other alternatives with similar present net values.

In addition to risks from herbicides and smoke, workers experience risk from accidents using equipment and working in rough terrain. The number of predicted accidents is directly correlated with the number of acres treated by manual means and the number of acres burned.

Alternative C ("no action") has by far the fewest number of accidents; Alternative D has the next fewest. All of the remaining alternatives have considerably more accidents, with Alternatives A and E having the most (due to increased acreages treated by hand in lieu of herbicides).

Figure IV-13 compares estimated yearly injuries to workers with an index for risk to the public from exposure to herbicides and fire smoke. Because risk is directly correlated to number of acres treated, risks to both the public and workers generally increase as level of management activity increases. For Alternatives A and E, more acres are treated by hand. This change in treatment causes some decrease in public risk, and some increase in worker risk from accidents.

The amount of smoke produced from both prescribed and wild fires is estimated in this EIS. The section on air quality earlier in this chapter displayed the total suspended particulates produced by prescribed fire per year.

Alternatives D and F produce significantly less suspended particulates than the rest of the alternatives, except Alternative C, which has no slash burning. (Smoke from wildfires is more dense, and the long-term risk of extensive wildfire is greatest in Alternative C.) All of the alternatives, when applied on a Regional level, meet the requirements of the State Implementation Plans and the State Smoke Management Plans.

There are a variety of economic effects associated with each alternative. One measure is the combined change in direct and indirect jobs in the Northwest. The total employment in Oregon and Washington is approximately three million.

There are no changes in employment for Alternative B. Alternative C reduces employment by about 22,000 jobs. Alternatives D and F reduce employment by about 3,000 jobs. Alternatives A and E reduce

employment by 1,100 and 1,400 jobs (respectively). Alternative G increases employment by 2,600 jobs.

There is the potential for additional adverse effects beyond those described above. The following effects were considered. They are not expected to be significant, as standards and guidelines and mitigating measures in the Forest Plans will be applied, as well as the mitigating measures identified in this EIS. The effects are:

- 1) short-term reduction in air quality from dust, smoke, and engine emissions resulting from vegetation management activities (other than prescribed burning);
- 2) localized reduction in long-term site productivity from burning of logging slash;
- 3) acceleration of natural rates of land slides and sediment by soil-disturbing activities associated with the use of heavy equipment for vegetation management projects;
- 4) a temporary increase in fire hazard from waste material left on the ground during vegetation management activities;
- 5) contamination of water sources due to increased human use of the Forest;
- 6) decrease in habitat for wildlife species (dependent on particular plant species and growth stages) due to vegetation management activities; and
- 7) damage to soils by compaction from heavy equipment used for vegetation management.

Irreversible and Irretrievable Commitments of Resources

“Irreversible commitments of resources” are actions which change either a nonrenewable resource (such as cultural resources or minerals), or which change a renewable resource to the point that it can only be renewed after 100 years or more.

Measures to protect resources that could be irreversibly affected by other resource uses are being incorporated into the standards and guidelines of the Forest Plans, and have been incorporated in the mitigation measures developed in this EIS. Two major irreversible commitments of resources are associated with the management of competing and unwanted vegetation, including slash burning, in the Pacific Northwest Region.

The use of fossil fuels to manage vegetation is an irreversible resource commitment. Alternatives that treat more acres would cause higher consumption of fossil fuels. Alternative G causes the highest consumption; Alternative C, the least.

Irreversible Resource Commitments

Vegetation management activities can cause irreversible losses in soil productivity. If prescribed fires violate the prescription, or if wildfires are severe, they can destroy humus and nutrients and reduce water infiltration. Improper use of machinery can also damage soil productivity through compaction and displacement.

An “irretrievable commitment of resources” is the loss of an opportunity for production or use of a renewable resource for a period of time. The difference between levels of services and goods under a given alternative and the higher levels that could be otherwise produced represents an irretrievable commitment of resources.

The difference in output levels is the opportunity cost, or lost production. These commitments are irretrievable because the opportunities are foregone. They are not irreversible, since they can be reversed by changing management direction in the future. Irretrievable resource commitments are summarized below.

Timber management—loss of timber volume production in areas where timber growth is slowed or forestalled by competing vegetation. This occurs to some degree in all alternatives except Alternative G. It is most adverse in Alternative C.

Wildlife—localized changes in populations due to changes in habitat.

Cost-efficiency—loss of cost-efficiency when resource objectives do not maximize the net monetary value. Alternative G has the highest net monetary value.

List of Preparers

Terry Solberg, *forester, interdisciplinary team leader (until 3/87)*

B.S., Forest Resource Management, 1964

Forest Service (21+ years):

Assignments with multiple resource program responsibilities on five districts (on four National Forests). One of these assignments was as District Ranger. Regional Office Group Leader, minerals impact evaluation (interdisciplinary) team in minerals and geology, 3-1/2 years. Chief's Office, Minerals and Geology staff, as program specialist, RPA and PD&B, 3-1/2 years. Deputy Forest Supervisor, Gifford Pinchot National Forest, 2 years.

Arnold G. Holden, *sociologist, interdisciplinary team leader (since 3/87)*

B.A., Sociology, Union College, 1964

M.A., Sociology, Michigan State University, 1967

Ph.D., Sociology, Michigan State University, 1972

Forest Service (7 years):

Pacific Northwest Region, Planning, 7 years.

Other employment: BLM, Alaska, 3 years; Oregon State University, 6 years.

David L. Caraher, *management analyst, assistant interdisciplinary team leader*

B.S., Range Management

M.S., Range Ecology

Forest Service (20 years):

District Assistant, Winema and Fremont National Forests, 6 years;

District Ranger, Ochoco National Forest, 7 years; Management Analyst, Regional Office, 7 years.

Thomas Atzet, *ecologist*

B.S., Forestry

M.S., Physiological Ecology

Ph.D., Plant Ecology

Forest Service (18 years):

Ecology, 12 years; Silviculture, 4 years; Sales Layout and Administration, 2 years.

Katherine C. Bowman, *writer/editor*

A.S., Forestry Technology, Central Oregon Community College, 1975

B.A., Interdisciplinary (Communications, Geography, Writing), Marylhurst Education Center, 1979

Forest Service (6 years):

Forestry Technician, Siskiyou National Forest, 2 years; Writer/Editor, Pacific Northwest Region and Pacific Northwest Research Station, 4 years.

Other employment: free-lance newspaper correspondent, 4 years.

Kimberly Brandel, *forestry/fuels management*

B.S., General Science, Portland State University, 1979

M.S., Forestry/Fire Science, Colorado State University, 1984

Forest Service (12 years):

Forester/Fuels Specialist, Wenatchee National Forest, 3 years; Forester (fuels), Fremont National Forest, 2 years; Forestry Technician (fire), Mt. Hood National Forest (seasonal), 7 years.

Richard Brown, *wildlife biologist*

B.A., Psychology, Reed College, 1971

Graduate studies in biology, Portland State University, 1975-1978

Forest Service:

Biologist, Mt. Hood National Forest 1981-1987.

Other employment: Research Associate, Oregon Rare and Endangered Plant Project, 1979-1980; Teaching Assistant, Biology, Portland State University, 1976-1978.

Jo Chappelle, *data coordinator and clerical assistant*

Forest Service (7 years):

Road Management; Engineering Technician; Purchasing Agent; Fiscal Management Receptionist, Gifford Pinchot National Forest.

Other employment: Receptionist for the Embassy of Switzerland in the Philippines.

John E. Deeming, *forestry meteorologist, fire management consultant*

B.S., Forest Management, Utah State University, 1959
B.S., Meteorology, University of California at Los Angeles, 1960
— Tropical Meteorology, University of Hawaii, 1962
— Biometeorology, Colorado State University, 1973

Forest Service (20 years):

Fire Scientist/Research Forester (18 years)
Southern Forest Fire Laboratory, Macon, GA
Rocky Mountain Research Station, Ft. Collins, CO
National Interagency Fire Coordination Center, Boise, ID
Intermountain Fire Science Laboratory, Missoula, MT
Pacific Northwest Research Station, Portland and Bend, OR
Region 6 Regional Meteorologist (2 years), Portland, OR

Other Employment: Weather Forecaster, United States Air Force, active duty (6.5 years); Staff Weather Officer, USAF Reserves (21 years); Fire Management Consultant (2 years).

Jan M. Engert, *forester, public information*

B.S., Forest Management

Forest Service (6 years):

Public Affairs; Planning; Field background in timber and other resources, Ochoco and Mt. Hood National Forests.

Nicholas Heyer, *industrial hygienist*

B.A., Physics, Reed College, 1967;
M.S.P.H., Environmental Health, University of Washington, 1980
M.H.A., Health Policy Analysis, University of Washington, 1981
Doctoral candidate, epidemiology, University of Washington. Completion expected 1987.

Employment: Industrial Hygienist, Harborview Medical Center

Other: Current member of the Washington State Governor's Right to Know Advisory Council, and the Steering Committee for Occupational Health Clinic Network, American Public Health Association.

Dale J. Pekar, *economist*

B.A., Economics and Sociology, Trinity University, 1971

M.S., Economics, Trinity University, 1972

Forest Service (7 years):

Economist.

Other employment: Economist, Corps of Engineers, New Orleans, LA, 3 years;
Contract Negotiator, USAF Air Logistics Command, San Antonio, TX,
3 years; Financial Case Worker, Texas State Department of Public
Welfare, San Antonio, TX, 1 year.

JoAnn Metzler, *hydrologist*

B.S., Watershed Science, Colorado State University, 1982

Forest Service (6 years):

Packwood Ranger District, Gifford Pinchot National Forest, 4 years;

Boise Ranger District, Boise National Forest, 2 years.

Steven P. Smith, *wildlife biologist*

B.S., Wildlife Science

B.S., Range Resource Management

Forest Service (9 years):

Range Conservationist, 5 years;

Wildlife Biologist, 4 years.

Mike Schafer, *forester (silviculturist/integrated pest management specialist)*

B.S., Forestry, University of Minnesota, 1968

Certified Silviculturist

Forest Service (17 years):

Forest Pest Management (Pacific Northwest Region), 2 years; Klamath
National Forest, (Pacific Southwest Region), 6 years; Grand Mesa-
Uncompahgre-Gunnison National Forest, (Rocky Mountain Region),
3 years; San Juan National Forest, 2 years; Rio Grande National Forest,
4 years.

Other employment: Hines Lumber Co. (Burns, OR), 1 year.

Jack Van Lear, *civil engineer*

B.S., Civil Engineering, California State Polytechnic University, 1971

Forest Service (16 years):

Assignments in all phases of engineering:

Angeles National Forest (Region 5); Six Rivers National Forest (Region 5); Sierra National Forest (Region 5); Chugach National Forest (Region 10); Regional Office (Region 10); Siuslaw National Forest (Region 6).

1944

1945

1946

1947

1948

1949

1950

1951

1952

1953

1954

1955

1956

1957

1958

1959

1960

List of Agencies,
Organizations,
and Individuals
to Whom Copies
of the Statement
Were Sent

List of Agencies, Organizations and Persons to Whom Copies of the Statement Were Sent

These are the agencies, organizations, and individuals who were listed to receive this DEIS as of early August, 1987. Others have been listed and have received copies since then.

Federal Agencies and Officials

Advisory Council on Historic Preservation, Washington DC

Agriculture, Department of

Agricultural Stabilization and Conservation Service, Washington, DC

Animal and Plant Health Inspection Service, Washington, DC

Forest Service, Washington DC

Regional Offices

Alaska Region, Juneau AK

Eastern Region, Milwaukee, WI

Intermountain Region, Ogden, UT

Pacific Southwest Region, San Francisco, CA

Rocky Mountain Region, Lakewood, CO

Southern Region, Atlanta, GA

Southwestern Region, Albuquerque, NM

Northern Region, Missoula, MT

National Forests

Colville	Mt. Hood	Umatilla
Deschutes	Ochoco	Umpqua
Fremont	Okanogan	Wallowa-
Gifford Pinchot	Olympic	Whitman
Malheur	Rogue River	Wenatchee
Mt. Baker-	Siskiyou	Willamette
Snoqualmie	Siuslaw	Winema

Experiment Stations

Pacific Northwest

Rocky Mountain

WESTFORNET - North, Seattle, WA

WESTFORNET - South, Berkeley, CA

Office of Equal Opportunity, Washington, DC
Rural Electrification Administration, Washington, DC
Soil Conservation Service, Washington, DC
State Conservationist, Portland, OR; Spokane, WA; and Davis,
CA

Architectural and Environmental Preservation, Office of, Washington, DC

Commerce, Department of

National Marine Fisheries Service
Southwest Division, Terminal Island, CA
Northwest Division, Portland, OR
NOAA Ecology/Conservation Division

Defense, Department of

Army Corps of Engineers, Washington, DC; Portland, OR; and Seattle,
WA
Deputy Assistant Secretary of Defense, Washington, DC
US Air Force, Environment and Safety, Washington, DC
US Navy, Environment Protection Division, Washington, DC
Naval Oceanography Division, Naval Observatory, Washington, DC

Energy, Department of

Bonneville Power Administration, Portland, OR
Office of Environmental Compliance, Washington, DC
Richland Operation Office, Richland, WA

Environmental Protection Agency

Region IX, San Francisco, CA
Region X, Seattle, WA

Federal Energy Regulatory Commission

Office of Environmental Review, Washington, DC

Federal Highway Administration

Region 10, Portland, OR
Region 9, San Francisco, CA

Federal Railroad Administration, Washington, DC

General Services Administration, Environmental Staff, Washington, DC

Health and Human Services, Washington, DC

**Housing and Urban Development Office of Environment and Review,
Washington, DC and Region IX**

Interior, Department of, Washington, DC

Bureau of Land Management, Portland, OR

Bureau of Indian Affairs, Portland, OR

Fish and Wildlife Service, Portland, OR

Interstate Commerce Commission, Washington, DC

National Aeronautics and Space Administration, Washington, DC

National Endowment for the Arts, Washington, DC

Nuclear Regulatory Commission,

Environmental Projects Office, Washington, DC

Occupational Safety and Health Administration, Washington, DC

Transportation, Department of

Environmental Division, Washington, DC

Federal Aviation Administration, Northwest Region, Seattle, WA; and

Western Region, Los Angeles, CA

Canada

Canadian Ministry of Environment and Parks, Victoria, BC

State and Local Agencies and Officials

Arizona Department of Transportation

Blue Mountain Intergovernmental Council

California Water Quality Control Board

California Division of Forestry

Clatsop-Tillamook Intergovernmental Council

Columbia River Intertribal Fish Commission

Conservation District, Asotin City

Conservation District, Kitsap County

Coos-Curry Council of Governments

County Commissioners, Oregon and Washington

Adams County	Harney County	Pend Oreille County
Asotin County	Hood River County	Polk County
Baker County	Island County	San Juan County
Benton County (OR)	Jackson County	Sherman County
Benton County (WA)	Jefferson County	Skagit County
Clackamas County	Josephine County	Skamania County
Clallam County	King County	Snohomish County
Clark County	Kitsap County	Spokane County
Clatsop County	Kittitas County	Stevens County
Columbia County (WA)	Klamath County	Thurston County
Columbia County (OR)	Klickitat County	Tillamook County
Coos County	Lake County	Umatilla County
Cowlitz County	Lane County	Union County
Crook County	Lewis County	Wahkiakum County
Curry County	Lincoln County (WA)	Walla Walla County
Deschutes County	Lincoln County (OR)	Wallowa County
Douglas County (WA)	Linn County	Wasco County
Douglas County (OR)	Malheur County	Washington County
Ferry County	Marion County	Wenatchee County
Franklin County	Mason County	Whatcom County
Garfield County	Morrow County	Wheeler County
Gilliam County	Multnomah County	Whitman County
Grant County (WA)	Okanogan County	Yakima County
Grant County (OR)	Pacific County	Yamhill County
Grays Harbor County	Pierce County	

County Weed Board - Asotin	County Weed Board - Snohomish
County Weed Board - Columbia	County Weed Board - Spokane
County Weed Board - Garfield	County Weed Board - Stevens
County Weed Board - Grant	County Weed Board - Whitcomb
County Weed Board - Lincoln	County Weed Board - Yakima
County Weed Board - Okanogan	County Weed Control - Umatilla
County Weed Board - Skamania	County Weed District - Morrow

Curry County Road Department
 Gleneden Beach Water District
 Idaho State, Division of Environment
 Karuk Tribe
 Klamath Lake Planning and Coordinating Council
 Lane Council of Governments
 Mapleton Water District

Mid-Columbia Economic Development District
Office of the Governor (CA), Planning and Research
Oregon Columbia River Gorge Commission
Oregon Department of Fish and Wildlife
Oregon Department of Agriculture
Oregon Department of Energy
Oregon Department of Environmental Quality
Oregon Department of Human Resources
Oregon Department of Transportation
Oregon State Department of Forestry
Oregon State Clearinghouse, Intergovernmental Relations Division
Oregon State Health Division
Oregon State Highway Division
Rogue Valley Council of Governments
Siskiyou County Board of Supervisors
Siskiyou County Agriculture Department
Suquamish Indian Tribe
Tacoma Department of Public Utilities
Warm Springs Confederated Tribe
Washington Columbia River Gorge Commission
Washington Association of Conservation Districts
Washington Department of Fisheries
Washington Department of Natural Resources
Washington Department of Agriculture
Washington Department of Ecology
Washington Department of Game
Washington Department of Transportation

Federal Congressional Delegation

Senator Mark O. Hatfield	Representative John Miller
Senator Bob Packwood	Representative Al Swift
Senator Daniel J. Evans	Representative Don Bonker
Senator Brock Adams	Representative Sid Morrison
Representative Les AuCoin	Representative Thomas Foley
Representative Bob Smith	Representative Norman Dicks
Representative Ron Wyden	Representative Mike Lowry
Representative Peter DeFazio	Representative Rodney Chandler
Representative Denny Smith	

Organizations and Businesses

Alder Hill Associates
American Fisheries Society
American Forest Council
American Forest Institute
American Forestry Association
Arden Tree Farms, Inc.
Archaeological Associates Northwest, Inc.
Associated Oregon Loggers, Inc.
Association of O & C Counties
Association of Oregon Counties
Association for Oregon Archaeology
Bloedel Timberlands Development Inc.
Blue Mountain Resource Council
Boise Cascade Corporation
Burlington Northern
CCD Economic Improvement Association
C & H Reforesters
Coastal Coalition for Alternatives to Pesticides
Caravansera Ranch
Cascade Head Ranch Water District
Cascade Holistic Economic Consultants
Cathedral Forest Action Group
Champion International Corporation
Citizens Action for a Safe Tomorrow
Columbia Basin Fish & Wildlife Council
Collier Spray & Tree Service, Inc.
Crook County Stock Growers
Douglas County Protective Association
Douglas County Timber Operators
Dow Chemical
DuPont Company
Earthcare
East Central Oregon Association of Counties
Eugene Register Guard
Federation of Western Outdoor Clubs
Forest Stewardship Services
Friends of the Columbia Gorge
Friends of the Columbia
Friends of the Earth

Friends of Snohomish River Delta
Fruitgrowers Supply Co.
Gaylord Pest Control
Gross & Son
Groundwork, Inc.
Headwaters
Hi-Ridge Lumber Company
Hood River Grower-Shipper Association
Idaho-Oregon Regional Planning and Development Association, Inc.
Integrated Forestry Services
Intermountain Urology Clinic
International Paper
International Snowmobile Industry Association
Issac Walton League
Jackson County Stockmens Association
Jones & Stokes Associates
Keep Oregon Green
Keep Washington Green
Lane County Audubon Society
Lively Livestock 4-H Club
Log Truckers Conference
Longview Fibre Company
Louisiana Pacific
Lower Columbia Audubon Society
Mason, Bruce and Girard
Mazamas Conservation Committee
Medford/Jackson Chamber of Commerce
Monsanto Company
Mountain Fir Lumber Co., Inc.
Mountain States Legal Foundation
Mountaineers
National Audubon Society
National Wildlife Federation
Native Plant Society of Oregon
Natural Resources Defense Council
Nature Conservancy
Northwest Coalition for Alternatives to Pesticides
North Coast Environmental Center
Northwest Forest Workers
Northwest Forestry Association
Northwest Mining Association

Northwest Pine Association
Northwest Timber Association
Northwest Independent Forest Manufacturers
Olympic Reforestation Inc.
Oregon Northern Coalition for Alternatives to Pesticides
Oregon Archaeological Preservation Committee
Oregon Association of Nurserymen
Oregon Association of Soil & Water Conservation Districts
Oregon Cattlemen's Association
Oregon Council Trout Unlimited
Oregon Environmental Council
Oregon Forest Industries Council
Oregon Forest Protection Association
Oregon National Heritage Data Base
Oregon Natural Resources Council
Oregon Sheepgrowers Association
Oregon Small Woodlands Association
Oregon Society of American Foresters
Oregon Student Public Interest Research Group
Oregon & Washington Agricultural Research Service
Oregon Wilderness Coalition
Oregon Wildlife Federation
Oregonians for Food and Shelter
Pacific Marine Technology
Pacific Northwest Ski Areas Association
Pacific Northwest Ski Association
Pine Mountain Lumber Co.
Plum Creek Timber Co., Inc.
Portland Audubon Society
Private Nursery Industry
Public Land News
Puget Sound Water Quality
Riddell, Williams, Bullitt, Walkinshaw
Rose Lodge Water Company
Roseburg Chamber of Commerce
Roseburg Forest Products Co.
Roza Irrigation District
Salmon River Concerned Citizens
Saltman & Stevens
Scientific Resources Inc.
Seattle Times

Seattle Water Department
Sequoia Forest Industries Inc.
Sierra Club
Sierra Club Legal Defense Fund
Siletz Tribal Forestry
Simpson Timber Company
Siskiyou National Forest Citizens Task Force
Snokist Growers
Southern Douglas Soil & Water Conservation District
Southern Oregon Timber Industries Association
Southern Oregon Resources Alliance
Southern Oregon Coalition for Alternatives to Pesticides
Southern Oregon Organics
Southwest Forest Industries
Starker Forests, Inc.
Stimson Lumber Company
Sunstuds
Survival Center
The Oregonian
Tilth Producers' Cooperative
Timber & Wood Products Group
Trout Lake Farm
TTS Technical Services
Two-MCK Logging
Union Carbide Agriculture Products, Inc.
Washington Audubon Society
Washington Farm Forestry Association
Washington Forest Protection Association
Washington Native Plant Society
Washington Pest Management Council
Washington State Association of Counties
Washington State Cattleman's Association
Washington State Horsemen, Inc.
Washington State Mineral Council
Washington Wilderness Coalition
Western Natural Resources Law Clinic
Western Washington Toxics Coalition
Western Wood Products Association
Western Forest Industries Association
Western Forestry & Conservation Association
Weyerhaeuser Company

Weyerhaeuser Forestry Research
Wilderness Society, Northwest Representative
Wildlife Management Institute
Wildlife Society, Oregon Chapter
Winchester Creek Company
World Forestry Center

Schools and Libraries

Central Oregon Community College Library
Central Washington University
Colorado State University, Libraries
Denver Public Library, Conservation Center
Green River Community College
Klamath County Library
Lewis and Clark College
Oregon State University Extension Service
Oregon State University, College of Forestry
Oregon State University, Entomology Department
Oregon State University, Forest Science Department
Oregon State University, School of Science
Portland State University, Political Science Department
University of Florida, Hume Library of Federal Documents
Utah State University, College of Natural Resources
University of Washington, College of Forestry Resources
University of Washington, Department of Environmental Health
University of Washington, Forest Resources Library
University of Washington, Office of Public Archaeology
Washington State University Extension Service
Washington State University, Department of Forestry and Range
Management
Washington State University, Archaeological Research Center
Whitman College, Penrose Memorial Library

Individuals

Tom Adams	Phil Andrus
Lorene Allen	Carol Ash
Dave Anderson	William A. Atkinson
M.E. Andre	Judith A. Barlow

Individuals, Continued

Andy Bayliss	Bill Dryden
Paul Bell	Julius H. Dunn, Jr.
Kris Benson	Curtis M. Eells
Bob Berends	Andrew Elsbree
Craig Benz	R.A. Emmett
Joanne Bigman	David E. Erion
Ronald Bjark	R. Kizk Ewart
Linda Blubaugh	Roger Fight
Bill Bradbury	Brian Flynn
Rob Burnett	Paul O. Frankenstein
Dave Draley	Kenneth Galloway, Jr.
Ellen Breiter	Marty Gianola
Molly Brewer	Dennis Haddow
Margaret Brown	Morey Haggin
Rob Burnett	George Halekas
Robert Burnham	Lars Halstrom
Ann Forest Burns	Kim Harrington
Donald Annard	B.L. Harris
Don & June Carlton	Von Helmuth
James T. Carroll	Fred L. Henley
George Case	Harry Hermes
D. L. Chare	Lucille Hermsen
Harold Christiansen	Joan Hett
Lynette Clark	Karen High
Woody Coats	Bonnie Hill
Jimmie O. Cobb	Michael Hill
Patric Connelly	John & Georgia E. Hoglund
Michael Conway-Brown	H.C. Hopkins
Lynn Coody	Cynthia Hovezak
Dave Corkran	Dennis H. Igou
Dennis P. Creel	Ben Iverson
Robert S. Cruikshank	Lawrence M. Jacobsen
Bill Crumb	Joe Karwal
Robert Curtis	Kevin C. Kehoe
Barbara K. Davis	Michael J. Kellett
Darrell Davis	Edward Kelley
Susanna DeFazio	Bruce Kelpsas
Harry Demaray	Mark Kelz
J.L. Dewitt	Jan Kenns

Individuals, Continued

Chris Kittell	Julie Norman
Randall Koch	W.H. Oberteuffer
Susan Kraus	R.M. Orum
Henry W. Kunz	Craig Patterson
Tom Lahaye	Jesse & Elaine Pattison
Louis Lamb	Warren Paulat
Harold P. Lange	Larry Pendarvis
Valerie Lantz	Russell Pengelly
Chloe Larvik	Perreault
Mark Lawler	Albert Petersen
Tom Lawler	Beth Peterson
Leroy W. Layton	Ira J. Pradmore
Robert M. Lee	Paulette Pyle
Russell and Marianne LeSage	Niki Eir Quester
Johanne A. Littany	Kent Quinkert
Gordon & Susan Longhurst	Leroy L. Ramm
Bud Lony	Margaretta Ramsey
Merle S. Lowden	Kris A. Ray
Wayne H. Madson	Marie Reeder
Robin Maliver	Mark Rehmar
Lucy Marrs	Ed Reynolds
Harriet Martin	Mike Rice
Ed Martiszus	Gerald R. Richardson
Hugh Massengill	Judy Roberts
Joseph A. Matejka	Steve Roberts
Russel M. Maynard	Thomas E. Robson
Norman R. McClum	John L. Rogers
Fergus McLean	Joe Ross
Bob Mealey	Sandra Rutledge
Paul Merrell	J. Sanchez
Bill and Diane Meyer	R. A. Sandmann
R. W. Metzger	Gordon R. Sanford
John R. Miller	Carolyn Saunders
Lee Miller	Fred Sawyer
Marge Morrison	Susanna Saxton
Linda Mycek	Norm Shaaf
Dan Newton	Mark E. Shaffer
John Nordheim	Thomas Sharkey
	Ann Seigenthaler

Individuals, Continued

Rocks L. Senger
Robert A. Simeone
Roy R. Simes
Ronald L. Simon
John B. and Ruth E. Smith
Sara Smith
Timothy C. Smith
Peggy Snow
John Soltau
A. E. Sowers
Ernie Soya
E. M. Sterling
R. D. Swartzlender
Susan Swift
Frank A. Terbush
George M. Thornton
Peggy Townley
Don Tryon
Frank Vaughn
Carol Von Strum
Fred Wahl
Judith Walls
James C. Webb
Duane Weiss
David F. Wershkul
R. D. Willhite
Kathy S. Williams
Mavrile Williamson
Paul S. Wilson
Floyd W. Wisely
Alan Withers
Harold W. Wood
Ben Worthington
Leslie P. Yates
E. Zahn

References

References

- Allen, G. G., Beer, J. W., and Cousin, M. J.
1978. Growth enhancement of a juvenile conifer forest six years after application of a controlled release herbicide. *International Pest Control*, Vol. 20:6-13.
- Ames, B.N., Magaw, R., and Gold, L.S.
1987. Ranking Possible Carcinogenic Hazards. *Science* 236:271-280.
- Arney, James
1986. User's Guide for the Stand Projection System (SPS), Rpt. No.1, Rev. 12/85 and 9/86. Applied Biometrics, Spokane, WA.
- Axleson O., et al.
1980. Herbicide Exposure and Tumor Mortality. *Scand J. Work Environ. Health* 6:73-79.
- Barnett, James W.
1982. Twenty year growth of ponderosa pine saplings thinned to five spacings in Central Oregon. USDA, FS. Res. Paper PNW-301.
- Baron, Frank J.
1962. Effects of different grasses on ponderosa pine seedling establishment. USDA, FS. Res. Note. PSW-199.
- Belz, Douglas
1987. Red alder severing window, 400 series second year report. Washington State Dept. of Natural Resources.
- Bennett, K.A.
1982. Effect of Slash Burning on Surface Soil Erosion Rates in the Oregon Coast Range. Master of Science Thesis, Oregon State University, Corvallis, OR.
- Bickford, M.L.
1965. Research Progress Report. Research Committee, Western Weed Control Conference. Albuquerque, NM.

Binkley, Dan

1984. Importance of size-density relationships in mixed stands of Douglas-fir and red alder. *Forest Ecology and Management*, 9 (1984) 81-85.

Binkley, Dan, Lousier, J.A., and Bradeley, A.J.

1981. Douglas-fir and nutrition as affected by Sitka and red alder. Unpub. manuscript, on file. Dept. of For. Science, Oreg. St. Univ., Corvallis, OR.

Bonneville Power Administration

May, 1982. Economic Demographic projection—Appendix I to Forecasts of Electricity Consumption."

Bormann, B.T.

1977. The magnitude and pattern of nitrogen accretion in *Alnus rubra* stands. Thesis. Univ. of Washington.

Boyer, Donald E., and Dell, John D.

1980. Fire Effects on Pacific Northwest Forest Soils. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region.

Brodie, J. Douglas, and Tedder, Philip L.

1982. Regeneration Delay: Economic Cost and Harvest Loss. *Journal of Forestry*, January 1982.

Brown, E. Reade

June, 1985. Management of Wildlife and Fish Habitats in Forest of Western Oregon and Washington. USDA Forest Service Pacific Northwest Region, in cooperation with USDI Bureau of Land Management.

Brown, G.W., and Krygier, J.T.

1970. Effects of Clear-Cutting on Stream Temperature. *Water Resources Research* 6(4):1133-1140.

Brown, G.W.

1974. Fish Habitat, In Environmental Effects of Forest Residue Management in the Pacific Northwest. A State-of-Knowledge Compendium. USDA-Forest Service General Technical Report PNW-24.

- Bull, Evelyn L., Thomas, Jack W., and Horn, Kirk
1986. Snag management on national forests in the Pacific Northwest. *Western Journal of Applied Forestry*—Vol. 1, no. 2 pp 41-43. April 1986.
- Calabrese, E.J.
1983. Scaling: an attempt to find a common denominator. In: "Principles of animal extrapolation" ed. Calabrese, E.J., New York, J.Wiley and Sons: pp. 499-527.
- California Air Resources Board
December, 1981. Information relating to development of a state ambient air quality standard for fine or inhalable particulates.
- Carlyle, J.C.
1986. Nitrogen cycling in forested ecosystems. In: *Forestry Abstracts*. 47(5):307-336.
- Cederholm, C.J., Reid, L.M., and Salo, E.O.
1981. Cumulative Effects of Logging Road Sediment on Salmonid Populations in the Clearwater River, Jefferson County, Washington, in *Salmon-Spawning Gravel: A Renewable Resource in the Pacific Northwest*. Rep. 39, pp. 38-74, Washington Water Research Cent., Pullman, WA.
- Chan, S. S.
1985. Competitive effects of over topping vegetation on Douglas-fir morphology in the Oregon Coast Range. Thesis abstract. CRAFTS program. Oregon St. Univ.
- Clarke, et al.
1970. *Veterinary Toxicology*. Bailliere Tindall, London.
- Clark, Roger N., and Stankey, George H.
1979. *The Recreation Opportunity Spectrum: A Framework for Planning, Management and Research*. Gen. Tech. Rep. PNW-98. Portland, OR: USDA-Forest Service, Pacific Northwest Forest and Range Experiment Station.
- Coats, R., et al.
1985. Channel Change, Sediment Transport, and Fish Habitat in a Coastal Stream: Effects of an Extreme J Event. *Environmental Management*, Vol. 9, No. 1, pp. 35-48.

Cole, Elizebeth, and Newton, Michael

1986. Nutrient, moisture, and light relations in 5-year-old Douglas-fir plantations under variable competition. *Can. Jour. For. Res.* Vol. 16:727-732.

Cole, Elizebeth, and Newton, Michael

1983. Inter and intraspecific competition in Douglas-fir plantations in the Oregon Coast Range. In: *Proc. West. Soc. Weed Science*. Las Vegas, NV, Mar, 1983.

Christenson, D. M., Young, J. A., and Evens, R.A.

1974. Control of annual grasses and revegetation in ponderosa pine woodlands. *Jour. of Range Management*. 27 (2) 143-145.

Conard, Susan

1986. Comparative water relations of three shrub species—preliminary results. Oregon St. Univ., For. Research Lab., Adaptive FIR Annual Rpt. 10/85-9/86. Medford, OR pp. 54-55.

Conard, S.G., and Radosevich, S.R.

1982. Growth responses of white fir to decreased shading and root competition by montane chaparral shrubs. *Forest Science*, Vol. 28 (2) 3090-320.

CPRC (Center for Population Research and Census)

Portland State University. "Components of Population Change, Oregon and Its Counties. April 1, 1980 to July 1, 1982".

Crouch, Glenn

1979. Atrazine improves survival and growth of ponderosa pine threatened by vegetative competition and pocket gophers. *Forest Science*. Vol. 25 (1) 99-111.

Crump, K.S. and Company, Inc.

May, 1986. Worst case analysis study of forest plantation herbicide use. Prepared for Forest Land Management Division, Department of Natural Resources, State of Washington.

Curtis, R.O., Clendenen, G.W., and DeMars, D.J.

1981. A new stand simulator for coast Douglas-fir: DFSIM user's guide. USDA, FS, Gen. Tech. Rpt. PNW-128.

Dahms, Walter

1950. The Effect of manzanita and snowbrush competition on ponderosa pine reproduction. USDA, FS, Res. Note PNW-65.

Davidson, I.W., Parker, J.C., and Beliles, R.P.

1986. Biological basis for extrapolation across mammalian species. *Regulatory Toxicol. Pharmacol.* 6:211-237.

De Bell, D.S., and Turpin, T.C.

Silvicultural Systems for the Major Forest Types of the United States, USDA, Forest Service, Agric. Handbk. No. 445, pp. 26-28. Rev. 12/83.

Dimock, E.J., Beebe, T.F., and Collard, E.B.

1983. Planting-Site preparation with herbicides to aid conifer reforestation. *Weed Science*. Vol. 31:215-221.

Dimock, Edward

1981. Herbicide and conifer options for reforesting upper slopes in the Cascade Range. USDA, FS., Res. Paper PNW-292.

Dost, F.N.

Sept. 17, 1986. An estimate of carcinogenic risk associated with polyaromatic hydrocarbons in smoke from prescribed burning in forestry. Submitted to Bureau of Land Management, Washington, D.C..

Douglas, J.E.

1981. Environmental Impacts of Weed Control Alternatives on Water. Proc. John S. Wright Forestry Conference, Weed Control in Forest Management, Purdue University. West Lafayette, NH.

Drew, John, and Flewelling, James

1979. Stand density management: an alternative approach and its application to Douglas-fir plantations. *For. Sci.* Vol. 25(3):518-532. Copyright 1979, by Soc. of Amer. For.

EPA

1980. An Approach to Water Resources Evaluation of Non-Point Silvicultural Sources (A Procedural Handbook). EPA-600/8-80-012.

EPA

1986. Pesticides in Ground Water: Background Document.

Everest, F.H., and Harr, R.D.

1982a. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America: 6 Silvicultural Treatments. GTR PNW-134.

Everest, F.H., and Harr, R.D.

1982b. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America: 9 Forest Chemicals. GTR PNW-149.

Fingerhut, M.A., et al.

1984. Review of exposure and pathology data for seven cases reported as soft tissue sarcoma among persons occupationally exposed to dioxin-contaminated herbicides. In: "Public health risks of the dioxins" ed. Lowrance, W.W., Los Altos, CA., Kaufmann, pp. 187-203.

Fiske, John

1984. Estimating effects of competing plants on conifer growth and yield, and determining release needs. Paper presented at Sixth annual Forest Vegetation Management Conference. Redding, California. Nov., 1984.

Fiske, John

1981. Evaluating the need for release from competition from woody plants to improve conifer growth rates. Pro 3rd Ann. For. Veg. Mgmt. Conf., pp. 25-44.

Fox, Thomas

1985. CRC #13 Monthly progress report. Forest Fertilization-West, 11/85.

Franklin, Jerry F.

1979. Ecological Characteristics of Old-Growth Douglas-fir Forests of the Blue Mountains of Oregon and Washington. Agriculture Handbook No. 553. Portland, OR: USDA-Forest Service, Pacific Northwest Forest and Range Experiment Station.

Fredrickson, R.L.

1970. Erosion and Sedimentation following Road Construction and Timber Harvest on Unstable Soils in Three Small Western Oregon Watersheds. USDA-FS Research Paper. PNW-104.

Froehlich, A.A.

1973. The Impact of Even-Age Management on Physical Properties of Soils. Paper 848, Oregon State University, Corvallis, OR.

Gordon, Donald

1962. Growth response of east side pine poles to removal of low vegetation. USDA, FS., Res. Note PSW-209.

Gratkowski, H.

1979. Growth of Douglas-fir after release from snowbrush ceanothus. Unpublished manuscript submitted to Forest Science, on file. Corvallis, OR: USDA, FS, Pacific Northwest Forest and Range Experiment Sta., Forestry Sciences Lab.

Gratkowski, H., Jaskowski, R., and Armstrong, L.

1978. Survival of Douglas-fir seedlings sprayed with atrazine, terbacil and 2,4-D. USDA, FS, Res. Paper PNW-256.

Gratkowski, H., and Lauterbach, P.

1974. Releasing Douglas-firs from varnishleaf ceanothus. Jour. of Forestry. 72(3):150-152:1974.

Hall, Frederick C.

1973. Plant Communities of the Blue Mountains in Eastern Oregon and Southeastern Washington. Pacific Northwest Region Guide 3-1. Portland, OR: USDA-Forest Service.

Hardell, L., and Eriksson, M.

1981. Soft tissue sarcomas, phenoxy herbicides and chlorinated phenols. Lancet (August 1):250.

Hardell, L., Eriksson, M., Lenner, P., and Lundgren, E.

1981. Malignant lymphoma and exposure to chemicals, especially organic solvents, chlorophenols and phenoxy acids: a case-control study. Br. J. Cancer 43:169-76.

Hardell, L., and Sandstrom, A.

1979. Case-control study: soft-tissue sarcomas and exposure to phenoxyacetic acids or chlorophenols. Br. J. Cancer 39:711-17.

Hart, R.W., and Fishbein, L.

1985. Interspecies extrapolation of drug and genetic toxicity data. In: "Toxicological Risk Assessment Vol I". Eds. Clayson, D.B., Krewski, D., and Munro, I., Boca Raton, FL. CRC Press; pp. 3-40.

- Harlow, David L., and others
1982. Recovery Plan for Peregrine Falcon (Pacific population).
USDI-Fish and Wildlife Service.
- Harr, R.D.
1976. Forest Practices and Streamflow in Western Oregon.
USDA-FS General Technical Report PNW-49.
- Harrington, T.B.
1985. Douglas-fir treatment means by site for the CRAFTS Coast
Range Competition Release Study: three years following treat-
ment application. CRAFTS progress report. Dept. of For. Sci.,
Coll. of For., Oregon St. Univ., Corvallis, OR.
- Harrington, T.B., Tappeiner, J.C., and Walstad, J.D.
1983. Predicting leaf area and biomass of tanoak and Pacific
madrone sprout clumps. Oreg. St. Univ., Corvallis, OR.
- Harris, Larry D.
1984. The Fragmented Forest—Island Biogeography Theory and
the Preservation of Biotic Diversity. University of Chicago Press.
- Helgerson, O.T., Gordon J.C., and Perry, D.A.
1984. N₂ fixation by red alder (*Alnus rubra*) and scotch broom
(*Cytisus scoparius*) planted under precommercially thinned
Douglas-fir (*Pseudotsuga menziesii*). In, Plant and Soil. Vol. 78
(1984), pp. 221-233.
- Hemstrom, M.A., and Logan, S.E.
1986. Plant association and management guide, Siuslaw National
Forest. USDA Forest Service, Pacific Northwest Region Publica-
tion No. R6-Ecol 220-1986a.
- Hemstrom, M.A., Logan, S.E., and Pavlat, W.
1985. Preliminary Plant Association Guide. Willamette National
Forest. USDA Forest Service, Pacific Northwest Region, Willam-
ette National Forest.
- Hoar, S.K., et al.
1986. Agricultural herbicide use and risk of lymphoma and soft
tissue sarcoma. JAMA 256(9):1141-1147.

Hobbs, S.D.

1986. Handwood overstory injection—Douglas-fir under-planting. Oregon St. Univ., For. Research Lab. Adaptive FIR Annual Rpt. 10/85-9/86. Medford, OR. pg. 17.

Hobbs, S.D., and Wearstler, K.A.

1985. Effects of cutting sclerophyll brush on sprout development and Douglas-fir growth. For. Ecology and Management. 13(1985)69-81.

Honchar, P.A., and Halperin, W.E.

January 31, 1981. 2,4,5-T, trichlorophenol and soft tissue sarcoma; Lancet :268-9.

Horowitz, Howard

March, 1982. Con[if]er-shrub growth interactions on proposed brush control sites in the Western Oregon Cascades. Thesis. Dept. of Geography, Univ. of Oregon.

Horowitz, H., Prull, G., and Cloud, J.

1978. Willamette Herbicides Study Project. Preliminary Rpt. Groundwok, Inc.

Howard, Kerry, and Newton, Michael

1984. Overtopping by successional coast-range vegetation slows Douglas-fir seedlings. Jour. of Forestry. 82(3):178-180.

Johnson, Charles, and Simone, Steve

1987. Plant Associations for the Wallowa-Snake Province. USDA-Forest Service, Wallowa-Whitman National Forest.

Johnson, R.R., Dixon, G.E., and Shroeder, D.I.

1986. The South Central Oregon/Northeastern California Prognosis (SORNEC). USDA, FS, Timber Mgmt.

King, S.P., and Radosevich, S.R.

1985. Herbicide tolerance in relation to growth and stress in conifers. Weed Science. Vol. 33: 472-478.

Knapp, W.H., Turpin, T.C., and Beuter, J.H. 1984. Vegetation control for Douglas-fir regeneration on the Siuslaw National Forest: a decision analysis. Jour. of Forestry. 82(3):168-172.

- Kraemer, J.F., and Hermann, R.K.
1979. Broadcast Burning: 25-Year Effects on Forest Soils in the Western Flanks of the Cascade Mountains. *Forest Science* Vol. 25 No. 3, pp. 427-439.
- Lanini, W.T., and Radosevich, S.R.
1986. Response of three conifer species to site preparation and shrub control. *For. Science*. 32(1):61-77.
- Lanini, W.T., and Radosevich, S.R.
1982. Herbicide effectiveness in response to season of application and shrub physiology. *Weed Sci.* Vol. 30:467-475.
- Lauterbach, P.G.
1976. Chemical weeding and release of conifers in Western Oregon and Washington. In: *Proc. Herbicides and Vegetation Management*. Oregon St. Univ., Sch. of Forestry; 148-151.
- Leege, Thomas A.
1976. Relationship of Logging to Decline of the Pet King Elk Herd. In: *Proceedings of the Elk-Logging roads Symposium*, December 16-17, 1975. Moscow, ID: University of Idaho, Susan R. Nieb, ed.
- Lorz, Harold W., et al.
1979. Effects of Selected Herbicides on Smolting of Coho Salmon, EPA-600/3-79-071.
- Lotan, James E., and Brown, James K., compilers.
1985. Fire's effects on wildlife habitat—symposium proceedings; 1984 March 21; Missoula, MT. General Technical Report INT-186. Ogden, UT: Intermountain Research Station; 1985. 96 p.
- Lynge, E.
1985. A follow-up study of cancer incidence among workers in manufacture of phenoxy herbicides in Denmark. *Br. J. Cancer*. 52:259-70.
- Lyon, Jack.
1985. Elk and Cattle on National Forests: A Simple Question of Allocation ...or a Complex Management Problem. *Western Wildlands*; Spring, 1985.

Lyon, L.J.

1984. Fire's effects on a small bird population/Lyon, L. Jack and Marzluff, John M. p. 16-22; 28 cm. In *Fire's Effects on Wildlife Habitat* (1984: Missoula, Montana) Fire's effects on wildlife habitat: symposium proceedings/compilers: James E. Lotan [and others].

Majke, J.T., et al.

1975. Mobility of 2,4,-D and 2,4,5-T n-Butyl Esters in Soils Following Massive Application to Field Mini-Lysimeters. *Journal Environ. Quality*. Vol. 11, No. 4.

Majke, et al.

1982. Dissipation of Massive Quantities of 2,4,-D and 2,4,5-T n-Butyl Esters in Field Mini-Lysimeters. *Journal Environ. Quality*. Vol. 11, No. 4.

Maser, Chris, Trappe, Hames M., and Ure, Douglas C.

1978b. Implications of small mammal mycophagy to the management of western coniferous forests. *Trans. North Am. Wildl. and Nat. Resour. Conf.* 43.

Maser, Chris, and Thomas, Jack Ward

1983. *Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon*. Introduction. USDA Forest Service Pacific Northwest Forest and Range Experiment Station.

Maser, Chris, and Trappe, James M.

1984. *The Seen and Unseen World of the Fallen Tree*. Gen. Tech. Rep. PNW-164. Portland, OR: USDA-Forest Service, Pacific Northwest Forest and Range Experiment Station.

May, J.W.

1968. *Dicamba and Picloram in Soil*. Ph.D. Thesis at Colorado State University. Microfilms, Inc. Ann Arbor, MI.

Mayer, F.L., Jr., and Ellersieck, M.R.

1986. *Manual And Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals*. USDI Fish and Wildlife Service Resource Publication 160. Washington, D.C.

- McDonald, Philip, and Fiddler, Gary
1986. Release of Douglas-fir seedlings: growth and treatment costs. USDA, FS, Res. Paper, Pacific Southwest Forest and Range Experiment Station.
- McDonald, P.M.
1982. Weeds in conifer plantations of Northeastern California—management implications. In: Proc. of a symposium—Management of the Eastside pine type in Northeastern California. Coop. Exten., Univ. of California and Soc. of Amer. Foresters; 70-78.
- McDonald, Philip
1978. Silviculture—Ecology of three native California hardwoods on high sites in North Central California. Thesis. Oreg. St. Univ., 4/78.
- Meevwig, R.O., and Packer, P.E.
1976. Erosion and Runoff on Forest and Rangelands. In: Watershed Management on Range and Forest Lands: Proceedings of the fifth Workshop of the United States/Australia Rangelands Panel; Boise, ID, June 15-22, 1975. Logan, UT. Utah State University.
- Miller, R.E., and Murray, M.D.
1970. The effects of red alder on growth of Douglas-fir. In: Proc. of a symposium—Utilization and management of red alder. USDA, FS, Gen. Tech. Rpt. PNW-70.
- Minore, D., Graham, J., and Murray, E.
1984. Environment and forest regeneration in the Illinois Valley area of Southwestern Oregon. USDA, FS, Res. Note PNW-413.
- Morrison, Michael L., and Meslow, E. Charles
198[4?]. Impacts of Forest Herbicides on Wildlife: Toxicity and Habitat Alteration. Department of Forestry and Resource Management University of California, Berkeley, California, and Cooperative Wildlife Research Unit, Oregon State University, Corvallis, Oregon.
- Murphy, S.D.
1986. Introduction and historical perspective of risk assessment. Washington Public Health 6(1):7-12.

National Research Council—Committee on the Institutional Means for Assessment of Risks to Public Health (NRC Committee) 1983.

Risk assessment in the federal government: managing the process. Washington D.C., National Academy Press.

Newton, Michael

1984. Vegetation management in plantations of the Pacific Northwest. Paper presented at Soc. of Amer. For. Convention, Quebec, Canada. Aug. 1984.

Newton, Michael

1978. Test of western hemlock wildlings in brushfield reclamation. For. Res. Lab., Res. Paper 39. Oreg. St. Univ., Sch. of For., Corvallis, OR.

Newton, M., and Dost, F.N.

1984. Biological and physical effects of forest vegetation management. September 24, State of Washington, Department of Natural Resources, Olympia.

Newton, M., El Hassan, B., and Zavitkowsky, J.

1968. Role of red alder in western Oregon forest succession. In: Proc. of symposium, Biology of alder. USDA, FS, Pac. Northwest For. and Range Exp. Sta., Portland, OR. pp. 73-84.

Newton, M., and Knight, F.B.

1981. Handbook of Weed and Insect Control Chemicals for Forest Resource Managers. Timber Press.

Newton and Norgren

1977. Silvicultural Chemicals and Protection of Water Quality. EPA 910/9-77-036.

Newton, M., and Norris, L.A.

1976. Evaluating Short- and Long-term Effects of Herbicides on Non-Target Forest and Range Biota. Symposium on Biological Evaluation of Environmental Impact, CEQ. Annual Meeting Ecological Society of America and AIBS. New Orleans.

Newton, M., and White, D.

1983. Effect of salmonberry on growth of planted conifers. Paper presented at 1983 Western Soc. of Weed Science Mtg., Las Vegas, NV.

- Norris, L.A.
1985. Accuracy and Precision of Analyses for 2,4-D and Picloram in Streamwater by Ten Contract Laboratories. In *Weed Science* Vol. 34:485-489.
- Norris, L.A.
1983. Entry and Fate of Pesticides in Air. In *Watershed and Fisheries Research at PNW, Proc. of Conf. at Grants Pass, OR.* Feb 23-24.
- Norris, L.A.
1982. The Behavior of Herbicides in the Forest Environment and Risk Assessment. *Proc. John S. Wright Forestry Conference, IN.*
- Norris, L.A.
1982. Behavior of Herbicides in Soil and Water in the Forest Environment. *Northeastern Weed Science Society, Jan. 5-7, Vol. 36, supplement.*
- Norris, L.A.
1981. The Movement, Persistence, and Fate of the Phenoxy Herbicides and TCDD in the Forest. *Residue Reviews, Vol. 80.*
- Norris, L.A.
1980. Behavior of Chemicals in the Forest Environment. *Pesticide Use Advisory memorandum 246, USDA-FS. Washington, D.C.*
- Norris, L.A., and Moore, D.G.
1981. Introduced Chemicals and Water Quality. *WSU Coop Extension Service, Pullman, WA.*
- Norris, L.A., et al.
1983. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America: 9 Forest Chemicals. *General Technical Report PNW-149.*
- Norris, L.A., and Montgomery, M.L.
1975. Dicamba Residues in Streams after Forest Spraying. *Bulletin of Environmental Contamination and Toxicology. Vol. 13, No. 1. New York*
- Norris, L.A., Montgomery M.L., and Warren, L.E.
1987. Triclopyr Persistence in Western Oregon Hill Pastures. In *Bulletin of Environmental Contamination and Toxicology, Vol. 39, (1).*

Office of Science and Technology Policy (OSTP)

1984. Chemical carcinogens: review of the sciences and its associated principles. Federal Register 49: 21595-21601.

Olliver, William

1984. Brush reduces growth of thinned ponderosa pine in Northern California, USDA, FS, Res. Paper PSW-172.

OMNI Environmental Services

May, 1987. Preliminary health effects evaluation for pollutants generated by field burning, slash burning, and residential wood combustion. Prepared for Oregon State Department of Environmental Quality.

Oregon State Department of Environmental Quality (Oregon DEQ)

February, 1987. Oregon toxic air pollutant emissions inventory.

Oregon State Department of Environmental Quality (Oregon DEQ)

June, 1986. Field and slash burning PM-10/TSP maximum impact study.

Osborn, J.G.

1980. Effects of Logging on Resident and Searun Populations of Cutthroat Trout (*Salmo clarki*) in Small Tributaries of the Clearwater River, Jefferson County, WA. 1978-1979. Final Rep. FRI-UW-8108. Fish. Res. Inst. Univ. of Washington, Seattle. 56 pp.

Owston, Peyton, and Davis, Valerie

1986. Monitoring growth of crop trees after release treatments. In, Proc. of For. Pest Mgmt. in Southwestern Oregon Workshop. Grants Pass, OR. Pub. July, 1986. pp. 55-62.

Owston, P.W., Greenup, M., and Davis, V.A.

1986. A method for assessing the silvicultural effects of releasing young trees from competition. USDA, FS, Gen. Tech. Rpt. PNW-191. Mar., 1986.

Ozkaynak, H. and Spengler, J.D.

February, 1986. Health effects of airborne particles. Energy and Environmental Policy Center, John F. Kennedy School of Government, Harvard University, Cambridge.

- Pearce, N.E., Smith, A.H., et al.
1986. Non-Hodgkin's lymphoma and exposure to phenoxyherbicides, chlorophenols, fencing work, and meat works employment: a case-control study. *Br. J. Indust. Med.* 43:75-83.
- Pekar, D.
1981. A Social Appraisal of Oregon's Northeast Counties. Baker, OR: USDA-Forest Service, Wallowa-Whitman National Forest.
- Perry, Charles, and Overly, Robert
1977. Impact of Roads on Big Game Distribution in Portions of the Blue Mountains of Washington, 1972-1973. Olympia, WA: Game Dept. Appl. Res. Sect. Bull. 11, 39.
- Perry, D.A. and Rose, S.L.
1980. Productivity of Forest Lands as Affected by Site Preparation. Presented at the Calif. Confs. on Forest Tree Nutrition and Soil Fertility, May 19-20, Redding, CA.
- Perry, D.A., et al.
1985. A Review of Literature Pertaining to Vegetation Management on the Siuslaw National Forest: Phase II. Oregon State University, Corvallis, OR
- Perry, D.A., Tappeiner J., and McGinley, B.
1985. A review of literature pertaining to vegetation management on the Siuslaw National Forest: Phase I—Early successional patterns, competition between trees and associated vegetation and efficacy of vegetation control techniques. *Oreg. St. Univ., Coll. of For., Corvallis, OR.*
- Peterson, S.
1983. Grazing impacts on bacterial water quality—Alsea Ranger District. Prepared for the U.S.D.A. Forest Service, Region VI.
- Peterson, S.
1983. Grazing Impacts on Bacterial Water Quality, Alsea Ranger District, 1981-1982. Unpublished report, Siuslaw National Forest.
- Petersen, Terry
1985. Grass competition in ponderosa pine plantations: patterns of tree response. Paper presented at 1985 Vegetation Mgmt. Conf., Oreg. St. Univ., Corvallis, OR.

Petersen, T., and Newton, M.

1982. Growth of Douglas-fir following release from snowbrush and forbs—implications for vegetation management of brushfields. Champion International Corp. Res. Note RM 82-8.

Petersen, T., and Newton, M.

1985. Growth of Douglas-fir following control of snowbrush and herbaceous vegetation in Oregon. Dow Chem. Co., Down to Earth. Vol. 41(1):21-25.

Preest, D.S.

1977. Long-term growth response of Douglas-fir to weed control. New Zealand Jour. of For. Science. 7(3):329-332.

Radian Corporation.

February 1986. Washington toxic air contaminants study—revised final report. Prepared for Washington State Department of Toxicology.

Radosevich, S. R., Passof P.C., and Leonard, O. A.

1976. Douglas-fir release from tanoak and Pacific madrone competition. Weed Science. 24(1):155-145.

Riihimaki, V., Asp, S., and Sven, H.

1982. Mortality of 2,4-D acid and 2,4,5-T acid herbicide applicators in Finland. Scand. J. Work Environ. Health 8:37-42.

Roberts, Catherine

1980. Second Year Report—Cooperative Brush Control Study, Mar. 1980.

Roberts, Catherine

1979. First Year Report—Cooperative Brush Control Study, Mar., 1979.

Rosenthal, Donald H., and Brown, Thomas D.

1985. Comparability of Market Prices and Consumer Surplus for Resource Allocation Decisions. Journal of Forestry. pp. 105-109, February, 1985.

Ross, D. W., and Walstad, J.D.

1986. Vegetative competition, site preparation, and pine performance: a literature review with reference to South Central Oregon, Oreg. St. Univ., Res. Bulletin 58.

Roy, Douglass

1975. Douglas-fir seed production and dispersal in Northwestern California. Unpublished report. On file. Redding, CA, USDA, FS, Pacific Southwest For. and Range Exper. Sta.

Roy, Douglass

1981. Effects of competing vegetation on conifer performance. Paper presented at 1981 Forest Vegetation Workshop, Oreg. St. Univer., Corvallis, OR. March, 3-5.

Rubenchik, B.L., Botsman, N.E., Gorban, G.P., and Levskaya, L.I.

1973. The Relation Between the Chemical Structure and Carcinogenic Activity of Urea Derivatives. *Onkologiya (Kiev)* 4:10-16.

Ruth, Robert

1956. Plantation survival and growth in two brush-treatment areas in Coastal Oregon. USDA, FS, Res. Paper No. 17.

Safe Drinking Water Committee

1977. Drinking Water and Health. National Academy of Sciences, Washington, D.C.

Schwarzbart, G., and Schmitz, P.

1982. Methods for Evaluating Energy Effects of Forest Management Alternatives, Vol. 1. Berkeley, CA: USDA-Forest Service, Management Sciences Staff.

Sedell, J.R., et al.

1981. Fish Habitat and Streamside Management: Past and Present. Proc. 1981 Conf., Soc. Amer. Foresters.

Seidel, Kenneth

1983. Growth of suppressed grand fir and Shasta red fir in Central Oregon after release and thinning—10 year results. USDA, FS, Res. Note PNW-404.

Seidel, Kenneth

1979. Regeneration in mixed conifer clearcuts in the Cascade Range and Blue Mountains of Eastern Oregon. USDA, FS, Res. Paper PNW-248.

- Serfis, James, Tinney, Richard, and McManus, Roger E.
July 1986. The Environmental Protection Agency's Implementation of the Endangered Species Act with Respect to Pesticide Registration. Center for Environmental Education, President's Council on Environmental Quality and the Environmental Protection Agency.
- Sidle, R.C.
1980. Impacts of Forest Practices on Surface Erosion. Pacific Northwest Extension Publication, PNW 195.
- Smith, A.H., et al.
1984. Soft tissue sarcoma and exposure to phenoxyherbicides and chlorophenols in New Zealand. JNCI 73(5):1111-17.
- Soule, Michael E., and Wilcox, Bruce, E., Eds.
1980. Conservation Biology, An Evolutionary - Ecological Perspective. Sunderland, MA: Sinaur Associates, Inc.
- Starkey, E.E.
1982. Impact of Fire on Nongame Wildlife in Rangeland Fire Effects: A Symposium, ed. by Ken Sanders, et al. USDI, Bureau of Land Management. Boise, Idaho State Office.
- State of Oregon
1982. Forestry Program for Oregon, an Action Program for the Eighties. Salem, OR: Oregon State Board of Forestry.
- State of Oregon
1980. State-wide Planning Goals and Guidelines. Salem, OR: Oregon Land Conservation and Development Commission.
- Steenhoff, Karen, and others.
1984. Pacific States Bald Eagle Recovery Plan (prepublication draft). U.S. Department of the Interior, Fish and Wildlife Service.
- Stein, William
1986. Research Progress Rpt. Study Title: Manual and chemical options for releasing Douglas-fir and noble fir from competing brush in the Cascade Range (FS-PNW-1201-8032). USDA, FS, Pacific Northwest Sta., Forestry Sciences Lab., Corvallis, OR. Apr. 30, 1986.

Stein, William

1986. Research Progress Rpt. Study title: Comparison of site preparation methods on Cascade Range Sites. (FS-PNW-10-1-8031). USDA, FS, Pacific Northwest Sta., Forestry Sciences Lab., Corvallis, OR. Apr. 30, 1986.

Stein, William

1986. Research Progress Rpt. Study Title: Comparison of site preparation methods on Coast Range sites. (FS-PNW-1201-8029). USDA-FS, Pacific Northwest Sta., Forestry Sciences Lab., Corvallis, OR. Jul. 23, 1986.

Stein, William

1986. Research Progress Rpt. Study Title: Manual and chemical options for releasing Douglas-fir from competing brush in Oregon's Coast Range. (FS-PNW-1201-8030). USDA, FS, Pacific Northwest Sta., Forestry Sciences Lab., Corvallis, OR. Jun. 10, 1986.

Stein, William

1984. The Coastal reforestation systems study—Five year results. USDA-FS, Pacific Northwest Sta., Forestry Sciences Lab., Corvallis, OR. Sept., 1984.

Stewart, R.E., Gross, L.L., and Honkala, B.H.

1984. Effects of competing vegetation on forest trees: a bibliography with abstracts. USDA, FS, Gen. Tech. Rpt. PSW-81.

Strothmann, R.O., and Roy, D.R.

1984. Regeneration of Douglas-fir in the Klamath Mountains Region, California and Oregon. USDA, FS, Gen. Tech. Rpt. PSW-81.

Tagart, J.V.

1976. The Survival from Egg Deposition to Emergence of Coho Salmon in the Clearwater River. Jefferson County, WA. MS Thesis, 101 pp., Univ. of Washington.

Tappeiner, John

1985. Tanoak and madrone effects on Douglas-fir regeneration—abstract of preliminary results. In: Proc. of 7th Annual For. Veg. Mgmt. Conf., Eureka, CA., Nov., 1985. pp. 91-97.

- Tappeiner, J., and Harrington, T.
1985. Tanoak-conifer competition as related to site occupancy and water use, second year results. *Oreg. St. Univ., FIR study FS 112*, June 7, 1985.
- Tappeiner, J.C., and McDonald, P.M.
1984. Development of tanoak understories in conifer stands. *Can. Jour. For. Res.* 14:271-277.
- Tappeiner, J.C., Harrington, T.B., and Walstad, J.D.
1983. Predicting the size and cover of tanoak and madrone sprout clumps up to six years after cutting or burning. *Oreg. St. Univ., Corvallis, OR*.
- Tesch, S.D.
1986. Seedling root and shoot growth severely impacted by sprout competition. *Oregon St. Univ., For. Research Lab., Adaptive FIR Annual Report 10/85-9/86*. Medford, OR. pp. 52-53.
- Tesch, S.D.
1985. Seedlings growing among brush sprouts get further behind after two years. *Oregon St. Univ., For. Research Lab., Adaptive FIR Annual Rpt. 10/84-9/85*. Medford, OR. pp. 50-51.
- Thiess, A.M., Frentzel-Beyme, R., and Link, R.
1982. Mortality study of persons exposed to dioxin in a trichloropheno-process accident that occurred in the BASF AG on November 17, 1953. *Am. J. Ind. Med.* 3:179-89.
- Thiessen, J.L.
1976. Some Relations of Elk to Logging, Roding, and Hunting in Idaho's Game Management Unit 39. In: *Proceedings of the Elk-Logging Roads Symposium*, December 16-17. 1975. Moscow, ID; University of Idaho, Susan R. Nieb, ed.
- Thomas, Jack W. and others
1979. Wildlife Habitats in Managed Forests of the Blue Mountains of Oregon and Washington. *Agriculture Handbook No. 553*. Portland, OR: USDA-Forest Service, Pacific Northwest Forest and Range Experiment Station.

- Topik, C., and Halverson, N.M.
1986. Plant Association and Management Guide for the Western Hemlock Zone Gifford Pinchot National Forest. USDA Forest Service, Pacific Northwest Region. R6-Ecol-230A-1986.
- Turpin, Thomas
1987. Successful silviculture operations without herbicides in a multiple use environment. Paper presented at Nat. Silv. Workshop. Sacramento, CA., May, 1987.
- Turpin, T. C., Radican, C., and Knapp, W.H.
1980. The effects of vegetation control on the success of conifer regeneration for the Siuslaw National Forest. USDA, FS, Corvallis, OR.
- U.S. Army Corps of Engineers
1971. Design Memorandum No. 1, Hydrology, Catherine Creek Lake, Catherine Creek, Oregon. Walla Walla, WA.
- U.S. Army Corps of Engineers
1964. Survey Report, Grande Ronde River and Tributaries, Oregon, Volume 1. Walla Walla, WA.
- U.S. Bureau of the Census
1980 Census of Population, "Characteristics of the Population, Number of Inhabitants"—Reports for Washington and Oregon PC80-1, 1981.
- U.S. Department of Agriculture, Forest Service
1984. Fate of Hexazinone in Southern Forest Watersheds. Forestry Bulletin R8-FB/P9.
- U.S. Department of Agriculture, Forest Service
1984. Pesticide Background Statements Vol. Herbicides, Agric. Handbook No. 633, Labat-Anderson, Inc.
- U.S. Department of Agriculture, Forest Service
1984. Draft Environmental Impact Statement, 1985-2030 Resources Planning Act Program. Washington, D.C.
- U.S. Department of Agriculture, Forest Service,
Pacific Northwest Region
1984. Regional Guide for the Pacific Northwest Region. May, 1984.

- U.S. Department of Agriculture, Forest Service,
Pacific Northwest Region
1987. RESERV Field Handbook, Rev. 2.0. Rogue River and
Siskiyou National Forests.
- U.S. Environmental Protection Agency
1986. Hazard Evaluation Division Standard Evaluation Procedure. Ecological Risk Assessment. Office of Pesticide Programs,
Washington DC, 20460.
- U.S. Environmental Protection Agency (USEPA)
November 23, 1984. Proposed guidelines for carcinogen risk
assessment; for exposure assessment; for mutagenicity risk as-
sessment; for health assessment of suspect developmental tox-
icants. Federal Register 49L 46294-46301; 46304-46312; 46314-
46321; and 46324-46331.
- U.S. Environmental Protection Agency (USEPA)
1976. Interim procedures and guidelines for health risks and
economic impact assessments of suspected carcinogens. Federal
Register 41:21402-21405.
- U.S. General Accounting Office
1986. National Forests, estimated costs and results of alternative
silvicultural treatments. GAO/RCED-87-61FS. Dec., 1986.
- Wagner, R.G., and Radosevich, S.R.
1986. Interspecific competition indices for vegetation manage-
ment decisions in young Douglas-fir stands on the Siuslaw
National Forest. Report #1, Dept. For. Sci., Coll. of For., Oreg. St.
Univ., Dec., 1986.
- Walstad, J.D. and Kuch, P.J.
1987. Forest vegetation management for conifer reproduction.
John Wiley & Sons, Pub., NY.
- Walstad, J.D., Brodie, J.D., and McGinley, B. C.
1986. Silvicultural value of chemical brush control in the manage-
ment of Douglas-fir. West. Jour. of Appl. For. 1(3):69-73.
- Weeks, Edward C.
1982. Plant Modernization and Community Economic Stability:
Managing the Transition. University of Oregon.

- White, Diane
1985. Effects of whiteleaf manzanita on Douglas-fir and ponderosa pine: water use strategies and growth. In: Proc. of 7th Annual For. Veg. Mgmt. Conf., Eureka, CA, Nov., 1985., pp 86-90.
- White, J., and Harper, J.L.
1970. Correlated changes in plant size and number in plant populations. Jour. of Ecology. Vol.58(2), 1970.
- Wu, T.L. et al.
1983. Herbicide Runoff from Experimental Watersheds. Journal of Environ. Quality. 12:330-336.
- Wykoff, W.R., Crookston, N.L., and Stage, A.R.
1982. User's guide to the stand Prognosis Model. USDA, FS, Gen. Tech. Rpt. INT-133.
- Yee C.S. and Roelofs, T.D.
1980. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America: 4. Planning Forest Roads to Protect Salmonid Habitat. USDA-FS General Technical Report PNW-109.
- Youngberg, C.T., and Wollum, A.G.
1976. Nitrogen accretion in developing *Ceanothus velutinus* stands. Soil Sci. 40:109-112.
- Zack, J.A., and Gaffey, W.R.
1983. A mortality study of workers employed at the Monsanto Company plant in Nitro, West Virginia. Environ. Sci. Res. 26:575-591.
- Zack, J.A., and Suskind, R.R.
1980. The mortality experience of workers exposed to tetrachlorodibenzodioxin in a trichlorophenol process accident. JOM 22(1)11-14.
- Zavitkowsky, J., Newton M., and El Hassan, E.
1969. Effects of snowbrush on growth of some conifers. Jour. of For., 67(4):242-246.

Glossary

Glossary

Absorption The taking up of liquids by solids or the passage of a substance into the tissues of an organism as the result of several processes; that is, diffusion, filtration, or osmosis.

Adsorption Adhesion of substances to the surface of solids or liquids. Technically, the attraction of ions of compounds to the surfaces of solids or liquids.

Action Threshold The level of competition or plant cover that triggers control action. In most cases this level is before unacceptable damage occurs.

Active Ingredient (a.i.) The effective part of a pesticide formulation, or the actual amount of the technical material present in the formulation.

Activity-Created Fuels Fuels created as a result of a management activity; for example, logging, thinning, and road construction.

Acute Health Effects Health effects that are immediate and obvious.

Acute Toxicity The potential of a substance to cause injury or illness when given in a single dose or in multiple doses over a period of 24 hours or less; in aquatic studies, exposure to a given concentration for 96 hours or less.

Air Contaminant Any substance within the atmosphere that is foreign to the natural atmosphere or that exceeds natural concentrations of the substance within the atmosphere.

Air Pollution The presence in the outdoor atmosphere of any dust, fumes, mist, smoke, other particulate matter, vapor, gas, odorous substances, or a combination thereof, in sufficient quantities and of such characteristics and duration as to be, or likely to be, injurious to health or welfare, animals or plant life, or property, or as to interfere with the enjoyment of life or property.

Air Quality The composition of air with respect to quantities of pollution therein; used most frequently in connection with "standards" of maximum acceptable pollutant concentrations. Used instead of "air pollution" when referring to programs.

Air Quality-Related Value A feature or property of an area that is affected in some way by air pollution. Examples include visibility, odor, flora, fauna, soil, water, geologic features, and cultural resources.

Airshed A term denoting a geographical area, the whole of which, because of topography, meteorology, and climate, shares the same air mass.

Allowable Sale Quantity The quantity of timber that may be sold from the area of suitable land covered by the Forest Plan for a time period specified by the plan. This quantity is usually expressed on an annual basis as the "average annual allowable sale quantity."

Ambient Air Air encompassing or surrounding a particular region; in particular, that

portion of the atmosphere, external to buildings, to which the general public has access.

Amenity Values An expression of the aspects of pleasantness or desirableness commonly associated with recreation, scenic and wildlife-related experiences.

Anaerobic Lacking in free oxygen.

Anadromous Fish Those species of fish, spawned in fresh water, which mature in the sea, and migrate back into fresh water streams to spawn. Salmon, steelhead, and shad are examples.

Animal Unit Considered to be one mature (1,000 lb.) cow or the equivalent based upon average daily forage consumption of 26 lbs. dry matter per day.

Animal Unit Month (AUM) The forage requirement for one month for a 1,000 pound mature animal (cow) or its equivalent (5 sheep).

AUM See Animal Unit Month.

Attainment Area A geographical area in which the quality of air is better than federal air pollution standards.

Available Land which has not been administratively or legislatively withdrawn from timber production.

Available Forage The amount of forage which may be removed without adversely affecting the vigor of the forage plants. (Normally considered to be about 50 percent of a grass plant.)

Available Fuel Portion of the total combus-

tible woody material that fire will consume under a given set of burning conditions.

Base Flow That portion of the water flowing in a stream which is due to ground water seepage into the channel.

Benefit-Cost Ratio Measure of economic efficiency, computed by dividing total discounted benefits by total discounted costs.

Big Game Large mammals hunted for recreation or meat; refers to elk and deer when used in this document and not otherwise qualified.

Bioaccumulation The uptake and temporary storage of a chemical in animal flesh and organs. Over a period of time, a higher concentration of chemical may be found in the organism than in the environment.

Bioconcentration The increase in the concentration of a chemical within organisms as it moves up through the food chain.

Biological Growth Potential The average net growth attainable in a fully stocked natural forest stand.

Biomass The amount of living and dead vegetative matter in a given area.

Board Foot A unit of quantity for lumber equal to the volume of a board 12 inches x 12 inches x 1 inch.

Broadcast Burn Allowing a prescribed fire to burn over a designated area within well-defined boundaries for reduction of fuel hazard or as a silvicultural treatment, or both.

Canopy The uppermost spreading, branchy layer of a forest.

Chronic Health Effects Health effects that may take repeated exposures over a period of months or years before becoming apparent. Chronic health effects may blend into the general health problems of life and never be detected.

Class I Areas Any area designated for the most stringent degree of protection from future degradation of air quality. Certain national parks, wilderness areas, and other federal reserves in existence on August 7, 1977 (that exceeded 10,000 acres in size) were designated as mandatory Class I areas by Congress in Prevention of Significant Deterioration Provisions of the Clean Air Act.

Class II Areas Any area cleaner than National Ambient Air Quality Standards which is designated for a moderate degree of protection from future air quality degradation. Moderate increases in new pollution may be permitted in Class II areas.

Class III Areas Any area cleaner than National Ambient Air Quality Standards which is designated for a lesser degree of protection from future air quality degradation. Significant increases in pollution may be permitted in a Class III area.

Class I Stream Perennial or intermittent streams (or segments thereof) that are direct sources of water for domestic use, or are used by large numbers of fish for spawning, rearing or migration, or flow enough water to be a major contributor to the quantity of water in a Class I stream.

Class II Stream Perennial or intermittent streams (or segments thereof) that are used by moderate though significant numbers of fish for spawning, rearing or migration, have a

moderate influence on a Class I stream, or are a major contribution to a Class II stream.

Class III Stream All other perennial streams or segments thereof not meeting higher class criteria.

Class IV Stream All other intermittent streams not meeting higher class criteria.

Clean Air Act (CAA) (42 USC 1857 et seq., 7501 et seq.) An act for air pollution prevention and control, (1) to protect and enhance public health and welfare and the productive capacity of its population; (2) to initiate and accelerate a national research and development program to achieve the prevention and control of air pollution; and (3) to provide technical and financial assistance to state and local governments in connection with the development and operation of regional air pollution control programs.

Clearcutting Removal of virtually all the trees, large or small, in a timber stand in one cutting operation. Leads to the establishment of an even-aged stand.

Climax The culminating stage in plant succession for a given site where the vegetation has reached a highly stable condition.

CMAI See Culmination of Mean Annual Increment.

CFR Code of Federal Regulations.

Clean Air Act As amended in 1977, this act requires all federal agencies to comply with all federal, state, and local air quality regulations.

Commercial Forest Land Forest land tenta-

tively suitable for the production of continuous crops of timber and that has not been withdrawn.

Commercial Thinning Any type of thinning of trees producing merchantable material at least equal to the value of the direct costs of timber harvesting.

Commodity A transportable resource product with commercial value; all resource products which are articles of commerce.

Community Types A generalized category comprising a number of similar stands of vegetation and including animal life.

Confine As used in reference to fire, to restrict a wildfire within determined boundaries established either prior to the fire, during the fire, or in an Escaped Fire Situation Analysis.

Conflagration A large and destructive fire (see Wildfire).

Contain As used in reference to fire, to surround a fire, and any spot fires therefrom, with control line as needed, which can reasonably be expected to check the fire's spread under prevailing and predicted conditions. May refer to a wildfire "contained" by topographic or geologic features, such as non-flammable cliffs or talus slopes.

Control In wildfire suppression, to complete the control line around a fire, any spot fires therefrom and interior islands to be saved; burn out any unburned areas adjacent to the fire side of the control line; and cool down all hot spots that are immediate threats to the control line.

Correction A strategy used in the alternatives that requires a high level of energy and

resources to reduce the damage or cover of unwanted vegetation to acceptable levels.

Corridor A linear strip of land identified for the present or future location of transportation or utility rights-of-way within its boundaries.

Corridor, Utility A strip of land, up to approximately 600 feet in width, designated for the transportation of energy, commodities and communications, by railroad, state highway, electrical power transmission (66 KV or more), oil, gas and coal slurry pipelines 10 inches in diameter and larger, and telecommunication cable and electronic sites for interstate use.

Corridor, Transportation A strip of land of variable width designated to accommodate the clearing and access control and visual resource limits of a highway or road facility, which may also be designated to accommodate one or more linear utilities.

Cost, Fixed A cost that is committed for the time horizon of planning or the decision being considered. Fixed costs include fixed ownership requirements, fixed protection, short-term maintenance, and long-term planning and inventory costs.

Cost, Investment A cost of creating or enhancing capital assets, including costs of administrative or common-use transport facilities and resource management investments.

Cost, Non-Forest Service A cost of investment and operating activities paid by cooperators or other non-Forest Service agencies, which are part of Forest Service management programs or which contribute to the outputs included in the analysis.

Cost, Operational For the National Forest System, a cost of activities to plan and manage controlled outputs, and for long-term protection and maintenance of capital assets. For State and Private Forestry and Research, operational costs include program activity costs. They are variable costs.

Cost Plus Net Resource Value Change (C+NVC) Cost including both the fixed annual cost for the protection organization (annual fire program budget) and the variable suppression (emergency fire fighting) costs; NVC is the difference in value of planned resource outputs on an area before and after a fire.

Cost, Variable A cost that varies with the level of controlled outputs in the time horizon covered by the planning period or decisions being considered. Variable costs include investment, operational, and variable general administration.

Cover Vegetation used by wildlife for protection from predators, to ameliorate conditions of weather, or in which to reproduce. See Hiding Cover; Thermal Cover.

Cover/Forage, Cover-Forage Area Ratio The ratio, in percent, of the amount of area in forage condition to that area in cover condition; the criteria by which potential deer and elk use of an area is judged.

Crop Tree Any tree forming, or selected to form, part of the final crop; generally a tree selected in a young stand for that purpose.

Crown Fire A fire that runs through the tops of trees, scrub or brushwood.

Culmination of Mean Annual Increment (CMAI) The age at which the annual incre-

ment of growth of a timber stand reaches its maximum.

Cultural Resources Buildings, sites, areas, architecture, memorials, and objects having scientific, prehistoric, historic, or social values.

Current Direction The existing direction in approved management plans; continuation of existing policies; standards and guidelines; current budget updated for changing costs over time; and, to the extent possible, production of current levels and mixes of resource outputs.

DBH See Diameter at Breast Height.

Demand Schedule A schedule of quantities of an output that users are willing to take at a range of prices, at a given time, and conditions of sale.

Departure Any timber harvest schedule which does not meet the definition of nondeclining evenflow.

Designated Areas Principal population centers or other areas requiring protection under state or federal air quality laws or regulations.

Developed Recreation Outdoor recreation requiring significant capital investment in facilities to handle a concentration of visitors on a relatively small area. Examples are ski areas, resorts and campgrounds.

Diameter at Breast Height (DBH) The diameter of a tree 4.5 feet above average ground level, except that in National Forest practice it is measured from the highest ground level. Abbreviated dbh. The additional abbreviations, ob and ib are used to designate whether the diameter refers to the measurement

outside or inside the bark.

Discount Rate, Nominal Discount rate expressed in terms of current dollars, and thus affected by the rate of inflation.

Discount Rate, Real A discount rate adjusted to exclude the effects of inflation.

Dispersed Recreation Outdoor recreation in which visitors are diffused over relatively large areas. Where facilities or developments are provided, they are more for access and protection of the environment than for the comfort or convenience of the people.

Diversity The distribution and abundance of different plant and animal communities and species within the area covered by a land and resource management plan.

Dose-Response Assessment Determines the probability of the adverse outcome for a given level of exposure.

Drift The movement of air-borne particles from the intended contact area to other areas.

Drift Deposition Derived from actual measurements and assumes conditions which meet current guidelines for aerial spraying. Wind direction is assumed directly toward the targets of concern and no allowance is made for herbicide degradation.

Ecosystem An interacting natural system including all the component organisms together with the abiotic environment.

Efficiency, Economic The usefulness of inputs (costs) to produce outputs (benefits) and effects when all costs and benefits that can be identified and valued are included in the computations. Economic efficiency is usually

measured using present net value, though use of benefit-cost ratios and rates-of-return may sometimes be appropriate.

Emission A byproduct of a mechanical or manufacturing process that is released into the atmosphere.

Empirical Yield Table A table showing, for one or more given species on a given site, the progressive development of a timber stand at periodic intervals covering the greater part of its useful life. This table is prepared on the basis of actual average stand conditions.

Endangered Species Any species of animal or plant which is in danger of extinction throughout all or a significant portion of its range. Plant or animal species identified by the Secretary of Interior as endangered in accordance with the 1973 Endangered Species Act, as amended.

Environment The aggregate of physical, biological, economic, and social factors affecting all organisms in an area.

Environmental Analysis An analysis of alternative actions and their predictable short- and long-term environmental effects, which include physical, biological, economic, social, and environmental design factors and their interactions.

Environmental Assessment A concise public document which provides sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement or a Finding of No Significant Impact. It aids in compliance with the NEPA when no Environmental Impact Statement is needed.

Environmental Impact Statement A document prepared by a Federal Agency in which

anticipated environmental effects of a planned course of action or development are evaluated.

Environmental Protection Agency (EPA) The federal agency with primary responsibility for enforcement of environmental regulations.

Ephemeral Stream A stream which dries up during part of the year.

Escaped Fire A fire which has exceeded, or is anticipated to exceed, preplanned initial action capabilities or the fire management direction.

Evaluation Plantation A plantation established to evaluate one or more genetic characteristics of the material in the plantation or its parents.

Even-age Management The application of a combination of actions that results in the creation of stands in which trees of essentially the same age grow together. Managed even-aged forests are characterized by a distribution of stands of varying ages (and therefore tree sizes) throughout the forest area. The difference in age between trees forming the main canopy level of a stand usually does not exceed 20% of the age of the stand at harvest rotation age. Regeneration in a particular stand is obtained during a short period at or near the time that the stand has reached the desired age or size for regeneration and is harvested. Clearcut, shelterwood, or seed tree cutting methods produce even-aged stands.

Evenflow See Nondeclining Evenflow.

Exposure Assessment Determines the level of exposure for a given agency policy or activity.

Fine Particulate Matter general terms refer-

encing particulate matter less than about 10 microns in diameter.

Fire-Dependent Ecosystem Ecosystems that require periodic disturbances by fire for maintenance of composition and structure.

Firing Technique A pattern of ignition of an area that causes the fire to burn in a prescribed manner; for example, heading or backing fire, spot fire, strip-head-fire, and ring fire.

Fire Intensity Level Fire intensity level; a measure of heat released over time by the flaming front of a fire; indicated by flame length.

Fire Management Direction Fire management standards, guidelines, and practices based upon land and resource management objectives. Fire management direction is used to define the kind, level, and timing of fire protection and use activities, including appropriate suppression strategies, which efficiently meet management objectives for each management area for the range of expected fire behavior conditions.

Fire Regime Fire's effects on an ecosystem depend upon fire type, frequency, duration, severity, and size. These five items define the characteristic fire regime of an ecosystem.

Fire Risk Potential for a fire start, natural or human-caused.

Firing Method Equipment or means of igniting a fire; examples are fusee, match, drip torch, and aerial drip torch.

First-Order Stream A headwater stream with no tributaries. Two first-order streams combine to form a second-order stream; two

second-order streams combine to form a third-order stream; etc.

Floodplain The lowland and relatively flat areas joining inland and coastal waters (including debris cones and flood-prone areas of offshore islands) including, at a minimum, that area subject to a 1 percent (100-year occurrence) or greater chance of flooding in any given year.

Forb Any herbaceous plant species other than those in the Gramineae (grasses), Cyperaceae (sedges), and Juncaceae (rushes) families; fleshy-leaved plants.

Forest Land Land at least ten percent occupied by forest trees of any size or formerly having had such tree cover and not currently developed for nonforest use.

Formulation The form in which a pesticide is packaged or prepared for use. A chemical mixture that includes a certain percentage of active ingredient (technical chemical) with an inert carrier.

Fuel Living or dead plant material that will burn.

Fuel Break A lane through forest or rangeland from which most combustible material, including trees and shrubs, has been removed or markedly reduced to prevent spread of fire.

Fuel Hazard A supply of fuel that forms a special threat of ignition or suppression difficulty.

Fuel Loading The amount of fuel present, expressed quantitatively as weight of fuel per unit area; generally expressed in tons per acre.

Fuel Management The practice of planning

and executing the treatment or control of living and dead vegetative material in accordance with fire management direction primarily for wildfire hazard reduction.

Fuel Type An identifiable association of fuel elements of distinctive species, forms, sizes, arrangements or other characteristics that will cause a predictable rate of fire spread or difficulty of control under specified weather conditions.

Goods and Services The various outputs, including on-site uses, produced from forest and rangeland resources.

Ground Fuel That fuel lying on or within six feet of mineral soil surface.

Guideline An indication or outline of policy or conduct.

Habitat The sum total of environmental conditions of a specific place occupied by a wildlife or plant species, or a population of such species.

Half-Life The time required for a chemical to be reduced to half of its original amount whether by excretion, metabolic decomposition, or other natural processes.

Herbicide A chemical substance used for killing plants.

Hiding Cover Vegetation capable of hiding 90 percent of a standing adult elk from the view of a human at a distance equal to or less than 61 meters (200 feet); generally, any vegetation used by elk for security or escape from danger.

Humus A general term for decomposed (plant and animal) residues in the soil; litter, there-

fore, being excluded. More specifically, the more or less stable fraction from the decomposed soil organic material, generally amorphous, colloidal, and dark colored.

Impact, Economic, Direct Impacts, caused directly by forest product harvest or processing, or forest uses.

Impact, Economic, Indirect Impacts that arise from supporting industries selling goods or services to directly-affected industries.

Impact, Economic, Induced Impacts resulting from employees or owners of directly or indirectly-affected industries spending their income within the economy.

Implementation Plan Detailed action document that translates the selected vegetation management alternative into on-the-ground instructions.

Inhalable Particulates Particulates less than 10 microns in diameter that are not filtered from the air, and consequently are inhalable into the upper respiratory system.

Integrated Pest Management A process for selecting strategies to regulate forest pests in which all aspects of a pest-host system are studied and weighed. The information considered in selecting appropriate strategies includes the impact of the unregulated pest population on various resources values, alternative regulatory tactics and strategies, and benefit and cost estimates for these alternative strategies. Regulatory strategies are based on sound silvicultural practices and ecology of the pest-host system and consist of a combination of tactics such as timber stand improvement plus selective use of pesticides. A basic principle in the choice of strategy is that it be ecologically compatible or acceptable.

Interactions Mixtures of chemicals may have substantially different toxicity than the sum of the toxicities of the components. The chemicals may interact to increase toxicity (synergism) or to decrease toxicity (antagonism).

Inversion A layer in the atmosphere where temperature increases with height or where the temperature decreases with height at a rate less than the dry adiabatic lapse rate.

K-V (Knutson-Vandenberg Act) An act of Congress which among other things authorizes the Forest Service to use funds collected from timber sales for tree planting, timber stand improvement and other forest uses.

Ladder Fuels Those fuels which tend to be continuous between the ground fuels and tree crowns, forming a "ladder" by which fire may spread into the tree crowns.

Landing A site where logs, harvested during a timber sale, are stored prior to removal from the Forest.

Land Management Planning The process of organizing the development and use of lands and their resources in a manner that will best meet the needs of people over time, while maintaining flexibility for a combination of resources for the future.

LC₅₀ A lethal concentration rate at which 50 percent of the test animals will be killed. Usually expressed in ppm and usually used in testing of fish or other aquatic species.

LD₅₀ A lethal dosage rate at which 50 percent of the test animals will be killed. Usually expressed in terms of milligrams of chemical per kilogram of body weight of the test animal (mg/kg).

Leaching Usually refers to movement of chemical through the soil by water; may also refer to movement of herbicides out of leaves, stems, or roots into the air or soil.

Lifestyle The characteristic way people live, indicated by consumption patterns, work, leisure, and other activities.

Long-Term Sustained Yield Timber Capacity The highest uniform wood yield from lands being managed for timber production that may be sustained under a specified management intensity consistent with multiple-use objectives.

Maintenance A strategy used in the alternatives requiring relative small doses of energy and resources to perpetuate a stable condition.

Management Concern An issue, problem or a condition which constrains the range of management practices identified by the Forest Service in the planning process.

Management Direction A statement that includes: multiple use and other goals and objectives, the associated management strategies, and standards and guidelines for attaining them.

Management Intensity A management practice or combination of management practices and associated costs designed to obtain different levels of goods and services.

Management Practice A specific action, measure, course of action, or treatment.

Management Strategy Management practices and intensity selected and scheduled for application on a management area to attain multiple use and other goals and objectives.

Mass Wasting Movement of soil or rock on slopes by gravitational forces and not directly by running water, usually involving movement of a portion of land surface. It includes slow displacement (such as creep) and rapid movement such as earthflows, rock slides, and avalanches.

Maximum Modification (Visual) See Visual Quality Objective.

MBF Thousand board feet.

Method A body of techniques. This document discusses five methods, biological, prescribed burning, manual, mechanical, and herbicides.

Microbial Degradation The breakdown of a chemical substance into simpler components by bacteria.

Micron one millionth of a meter; a micrometer.

Microorganism A living organism so small that it can be seen only with a microscope.

MIH Management Information Handbook

Minority Persons as specified in Directive 15, Office of Federal Statistical Policy and Standards, U. S. Department of Commerce, Statistical Policy Handbook (1978). Generally identified as one of the following four categories: Alaskan Native or American Indian, Asian or Pacific Islander, Black, Hispanic.

MMBF Million board feet.

National Ambient Air Quality Standards Allowable concentrations of certain air pollutants in the ambient air as specified by the federal government (40 CFR Part 50). Ambient air quality standards are divided into primary

standards and secondary standards. Primary standards are designed to protect public health; secondary standards are designed to protect public welfare. Welfare is defined as including, but not limited to, effects on soils, water, crops, vegetation, animal, weather, and visibility. Standards have been developed for carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, ozone, and particulate matter.

Natural Fuels Fuels that are a result of natural processes such as blowdown, insect epidemics, and other causes of mortality.

NEPA The National Environmental Policy Act of 1969.

NEPA Process A process, mandated by NEPA, which concentrates decisionmaking around issues, concerns, alternatives and the effects of alternatives on the environment.

Net Value Change The difference in value of planned resource outputs on an area before and after a fire.

NFMA The National Forest Management Act of 1976.

NFMAS National Fire Management Analysis System. A computer-based simulation system that tests the effectiveness of a proposed fire suppression organization and/or fire management strategy, program, or policy.

No Action See Current Direction. Also one of four strategies used in the alternatives. No action means no interference with natural process by man.

Nominal Dollars A value from which the effect of change in the purchasing power of the dollar has not been removed.

Nonattainment Area An area designated by EPA as not meeting federal ambient air quality standards.

Nondeclining Evenflow A harvest schedule for timber or any other resource in which the average annual harvest may increase or remain static through time but never decrease.

Noxious Weeds Species of plants that cause disease or are injurious to crops, livestock, or land.

Old-Growth An old-growth stand is defined as any stand of trees ten acres or greater generally containing the following characteristics: 1) stands contain mature and overmature trees in the overstory and are well into the mature growth stage; 2) stands will usually contain a multi-layered canopy and trees of several age classes; 3) standing dead trees and down material are present; and 4) evidence of man's activities may be present, but do not significantly alter the other characteristics and would be a subordinate factor in a description of such a stand.

Opportunity Cost The dollar-quantifiable net loss resulting from selecting a less efficient course of action.

Overstory The portion of trees in a forest which forms the uppermost layer of foliage.

Pacific Northwest Region Includes the States of Oregon and Washington, portions of two counties in California, and parts of three counties in Idaho. The Region (sometimes called "Region 6") contains 19 National Forests and one National Grassland.

Particulate Any dispersed aggregate matter, solid or liquid (other than water), that is sus-

pendent in or falling through the atmosphere.

Payments to Local Governments Payments to local or State governments based on ownership of Federal land and not directly dependent on production of outputs or receipt sharing. Specifically, they include payments made under the Payments in Lieu of Taxes Act of 1976 by U. S. Department of the Interior.

Permittee A holder of a permit to use National Forest land for a specific purpose.

Person-Day The equivalent to one person working for 8 hours.

Phenoxy Herbicides Chemicals having herbicidal properties and a chemical structure consisting of a phenyl ring attached to an oxygen, which is in turn attached to a carboxylic group. Examples of phenoxy herbicides are 2,4-D, MCPA, 2,4,5-T and 2,4,5-TP (Silvex).

Photodecomposition The breakdown of a substance, especially a chemical compound, into simpler components by the action of radiant energy.

Pioneer Species A plant capable of invading bare sites (e.g., a newly exposed soil surface) and persisting there, i.e., "colonizing" them, until supplanted.

Planned Ignition A fire started by a deliberate management action.

PM-2.5 References proposed air quality standard for particulate matter less than 2.5 microns in diameter.

PM-10 References proposed air quality standard for particulate matter less than 10 microns in diameter.

PNV See Present Net Value.

ppb Parts per billion.

ppm Parts per million.

Present Net Worth See Present Net Value.

Prevention One of four strategies used in the alternatives. Prevention requires early action, well before competition or plant cover causes damage, and relatively small amounts of energy and resource input.

Prevention of Significant Deterioration (PSD) A program identified by the Clean Air Act to prevent air quality and visibility degradation and to remedy existing visibility problems. Areas of the country are grouped into three classes which are allowed certain degrees of pollution depending on their uses (See Class I, II, and III Areas).

Policy A guiding principle upon which is based a specific decision or set of decisions.

Potential Yield The sustainable output level of wood fiber available after deductions for other resource needs.

Precommercial Thinning Any type of thinning that takes place in a stand of trees before the size or condition of the material cut or killed makes it of sufficient value to meet the costs of the activity.

Prescribed Burning Intentional application of fire to forest or rangeland in their natural or modified state to meet specific management objectives.

Prescription (Silvicultural) The formal written plan of action to carry out a silvicultu-

ral treatment of a forest stand to achieve specific objectives.

Present Net Value Discounted benefits less discounted costs.

Preservation (Visual) See Visual Quality Objective.

Programmed Harvest Timber scheduled for harvest for a specific year.

Public Issue A subject or question of widespread public interest relating to management of the National Forest System.

PUM Piling of unmerchantable material.

Rate-of-Return The annualized net profit on an investment, expressed as a percentage.

Rate of Spread The amount that a fire extends its horizontal dimensions within a unit of time. This can be expressed as forward rate of spread of the advancing fire front, area increase rate, or perimeter increase rate.

Ravel Downslope movement of sediment particles or small rocks on steeper slopes without flowing water. The particles are dislodged by a combination of gravity, changes in temperature, and wetness and wind, or animals.

Real Dollar Value A monetary value which compensates for the effects of inflation.

Recreation Opportunity Spectrum (ROS) An array of recreational activities, settings, and experiences used as a basic framework in planning and managing the recreation resource. This spectrum is divided into the following classes: primitive, semiprimitive

non-motorized, semiprimitive motorized, roaded natural, rural, and urban.

Recreation Visitor Day The use of an area by one or more people for 12 person-hours, either continuously or spread over several visits. One person visiting a recreation site for one day (12 hours) is one recreation visitor day (RVD).

Reforestation Reforestation includes measures to obtain natural regeneration, as well as tree planting and seeding. The work is done on National Forests to produce timber and other forest products, protect watersheds, prevent erosion, and improve other social and economic values of the forests, such as wildlife, recreation, and natural beauty.

Regeneration The renewal of a tree crop, whether by natural or artificial means. Also the young tree crop itself.

Regional Haze A haze with no attributable source, over a large area.

Research Natural Area An area, typifying an important forest, shrubland, grassland, alpine, aquatic, or geologic type or other natural situation that has special or unique characteristics, which is set aside to provide a benchmark for education and research.

Respirable Particulate Matter That portion of the total particulate matter, that, because of its size (smaller than 2 to 3 microns), has an especially long residence time in the atmosphere and penetrates deeply into the lungs.

Riparian Habitat That portion of a watershed or shoreline influenced by surface or subsurface waters, including stream or lake margins, marshes, drainage courses, springs and seeps.

Riparian Vegetation Nonaquatic vegetation found within riparian areas. Typically, this vegetation is dependent upon a seasonally high water table.

Risk Assessment An analytic process that is firmly based on scientific considerations, but also requires judgements to be made when the available information is incomplete. These judgements inevitably draw on both scientific and policy considerations.

Risk Characterization Describes the nature and magnitude of the human risk. Risk characterization uses the information gathered in the other stages to represent the overall situation. The assessment of toxicity, along with levels and probability of exposure, are joined to estimate risk.

Risk Management The process of weighing policy alternatives and selecting the most appropriate regulatory action, integrating the results of risk assessment with engineering data and with social, economic and political concerns to reach a decision.

Rotation (as used in reference to timber) The period of years between the initial establishment of a timber stand and the time when it is considered ready for cutting and regeneration.

Scablands Shallow-soiled lands typically dominated by such species as low and stiff sagebrush.

Scoping Process A process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action.

Sedimentation Transport of eroded soils to a stream channel.

Seed Orchard A plantation of selected clones or progenies which is isolated or managed to avoid or reduce pollination from outside sources, managed to produce frequent, abundant and easily harvested crops of seed.

Sensitive Species (list) A list maintained by the Region of sensitive species that have particular scientific or management value, nationally or locally. These species may be locally rare—they may be abundant elsewhere—or have a limited population. The list includes species from state and Federal lists. Federally-listed species legally require protection.

Seral A biotic community which is a developmental, transitory stage in an ecologic succession.

Serotiny Cones that require heat to open and release seeds.

Shade Tolerant Trees Trees which reproduce and form understories beneath canopies of less tolerant trees or even beneath shade of their own species.

Shade Intolerant Trees Trees which reproduce successfully only in the open or where the canopy is greatly broken.

Silviculture The art and science of controlling the establishment, composition, competition, and growth of forests.

Silvicultural System A management process whereby forests are tended, harvested, and replaced, resulting in a forest of distinctive form. Systems are classified according to the method of carrying out the fellings that remove the mature crop and provide for regeneration, and according to the type of forest thereby produced.

Slash The vegetative residue left on the ground after trees are felled or accumulated as a result of storm, fire, or silvicultural treatment.

Smoke Management Conducting a prescribed fire under fuel moisture and meteorological conditions, and with firing techniques that keep the smoke's impact on the environment within acceptable limits.

Smoke Sensitive Area An area that may be negatively impacted by smoke but is not classified as a designated area.

Social Organization The structure of a society described in terms of institutions, community cohesion and community stability.

Sorption The ability of particulate matter to bind another substance either to its surface or its interior.

Stable Atmosphere A layer in which the vertical movement of air is damped. An emission would not "mix" vertically in a stable atmosphere, hence dilution would be very slow.

Standard A principle requiring a specific level of attainment, a rule against which to measure.

State Implementation Plan (SIP) A document which describes a comprehensive plan of action for achieving specified air quality objectives and standards for a particular locality or region within the state, within a specified time period.

Strategy a carefully planned course of action. Four strategies are incorporated into the alternatives presented, no action, prevention,

correction, and maintenance.

Successional Stage A stage or recognizable condition of a plant community which occurs during its development from bare ground to climax.

Suitability The appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of the economic and environmental consequences and the alternative uses foregone. A unit of land may be suitable for a variety of individual or combined management practices.

Suitable See Commercial Forest Land.

Summer Range A portion of the total range on which big-game animals normally find food and cover during summer months.

Supply The amount of an output that producers are willing to provide at a specific price, time period, and conditions of sale.

Suppression Action to limit the spread, and to prevent damage, by a wildfire.

Sustained Yield of Products and Services The achievement and maintenance in perpetuity of a high level annual or regular periodic output of the various renewable resources of the National Forest System without impairment of the productivity of the land.

Technique How a basic method is used.

Theme A theme characterizes the quality of an action.

Thermal Cover Cover used by animals to ameliorate effects of weather; for elk, a stand of coniferous trees 12 meters (40 feet) or more

tall with an average crown closure of 70% or more; for deer, cover may include saplings, shrubs, or trees at least 1.5 meters (5 feet) tall with 75% crown closure.

Threatened Species Any species listed in the Federal Register, which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Thinning A felling made in an immature tree crop or stand in order primarily to accelerate diameter increment but also, by suitable selection, to improve the average form of the trees that remain, without—at least according to classical concepts—permanently breaking the canopy.

Timber Production The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use. For purposes of this definition, the term “timber production” does not include production of fuelwood.

Tolerance The forestry term for expressing the relative capacity of a tree to compete under low light and high root competition.

Tool An instrument used for operation. In this document a brush blade or chain-saw is referred to as a tool used in manual methods.

Total Suspended Particulate Matter (TSP) Amount of particulate materials of all sizes (mass basis) suspended in a unit volume of the atmosphere at a point in time.

TOXIC Relating to a harmful effect by a poisonous substance on the human body by physical contact, ingestion, or inhalation.

Toxicologic Hazard Identification Determines whether or not a particular chemical is causally linked to an adverse health outcome.

Tractor Logging In timber harvesting, any logging method which uses a tractor or other mobile surface unit as the motive power for transporting logs from the stumps to a collecting point, whether by dragging or carrying.

Transitory Range Land that is suitable for grazing use of a non-enduring or temporary nature over a period of time. For example, on particular disturbed lands, grass may cover the area for a period of time before being replaced by trees or shrubs not suitable for forage.

Transportation Corridor See Corridor.

Uncertainty May be due to missing information, or gaps in scientific theory. Whenever uncertainty is encountered, a decision, based upon scientific knowledge and policy considerations, must be made. The term scientific judgment is used to distinguish this decision from policy decisions made in risk management.

Understory In silviculture, trees growing under the canopy formed by taller trees; in range management, herbaceous and shrub vegetation under a brushwood or tree canopy.

Unplanned Ignition A fire started at random by either natural or human causes, or a deliberate incendiary fire.

Unproductive As used in reference to timber production, forest land which does not grow 20 cubic feet per acre per year of merchantable timber.

Unregulated Timber which was not considered (because of land allocations or condition of trees) in calculating a base sale schedule or departure. Unregulated timber includes salvage of epidemic mortality, volumes of cull material, or green volumes from unsuited lands.

Unstable Atmosphere A layer in which the vertical movement of air is enhanced. An emission would mix rapidly in an unstable atmosphere; hence, dilution would be very efficient.

USDA United States Department of Agriculture.

USDI United States Department of the Interior.

Utilization Methods that reduce vegetative residue through improved harvest techniques or through higher utilization standards.

Utility Corridor See Corridor.

Value, Market The unit price of an output normally exchanged in a market after at least one stage of production, expressed in terms of what people are willing to pay as evidenced by market transactions.

Value, Non-Market The unit price of a non-market output not normally exchanged in a market at any stage before consumption, and thus must be imputed from other economic information.

Visibility How far a given object can be seen by the human eye. The greatest distance in a given direction at which it is just possible to see and identify, with the unaided eye in the daytime, a prominent dark object and, at night, a known, preferably unfocused, moder-

ately intense light source.

Visibility Impairment Any humanly perceptible change in visibility (visual range, contrast, coloration) from that which would have existed under natural conditions. See section 169(g)6 of the Clean Air Act.

Visual Quality Objective A combination of inherent scenic quality and public interest which defines the acceptable degree of alteration for any given area.

Volatilization Vaporization of a substance.

Wetlands Those areas that are inundated by surface or ground water with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats and natural ponds.

Wilderness Lands designated by law as wilderness; no road building or timber harvesting is allowed on such lands; they are intentionally managed to maintain their primitive character.

Wildfire Any wildland fire that requires a suppression response.

Winter Range A range, usually at lower elevation, used by migratory deer and elk during the winter months; usually smaller and better-defined than summer ranges.

YUM Yarding of unmerchantable material to the landing.

1. The first part of the paper discusses the importance of the study of the history of the English language. It is a branch of linguistics which deals with the changes in the language over time.

2. The second part of the paper discusses the importance of the study of the history of the English language. It is a branch of linguistics which deals with the changes in the language over time.

3. The third part of the paper discusses the importance of the study of the history of the English language. It is a branch of linguistics which deals with the changes in the language over time.

4. The fourth part of the paper discusses the importance of the study of the history of the English language. It is a branch of linguistics which deals with the changes in the language over time.

5. The fifth part of the paper discusses the importance of the study of the history of the English language. It is a branch of linguistics which deals with the changes in the language over time.

6. The sixth part of the paper discusses the importance of the study of the history of the English language. It is a branch of linguistics which deals with the changes in the language over time.

7. The seventh part of the paper discusses the importance of the study of the history of the English language. It is a branch of linguistics which deals with the changes in the language over time.

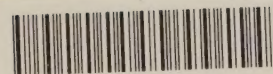
Index

Index

Accidents	II-25
Air Quality	III-11; IV-31
Alternatives	
Alternative A	II-6
Alternative B	II-8
Alternative C	II-10
Alternative D	II-12
Alternative E	II-14
Alternative F	II-16
Alternative G	II-18
Acreages and Effects	II-86
Compared	II-21
Description	II-3
Eliminated	II-47
Implementing	II-51
Overview	II-4
Preferred	II-20
Climate	III-5; IV-13
Costs and Benefits	I-10; II-31; IV-129; Appendix B
Cultural Resources	III-45; IV-82
Diversity	III-31; IV-60
Effectiveness of Techniques	I-11; II-41
Energy	IV-83
Environmental Analysis	I-14; II-51
Environmental Effects	I-12; II-36
Facilities	III-41; IV-78
Fire	III-7; IV-28
Fisheries	III-37; IV-71

Five Steps	
Action	II-60
Monitoring	II-60
Project Design	II-58
Site Analysis	II-54
Strategy	II-55
Forest Plans	I-17
Geology	III-4; IV-13
Herbicides	II-27; III-46; IV-85; Appendices C, D, H
Human Health	I-7; II-24; III-46; IV-118; Appendices D, H
Incomplete or Unavailable Information	IV-6; Appendix H
Insects and Disease	III-38; IV-76
Irreversible, Irretrievable Commitments	IV-139
Interagency Cooperation	I-13; II-45; Appendix I
Issues	I-6; II-22
Land Uses	III-39; IV-76
Legislation	I-19
Location	III-1
Mitigation Measures	
Biological	II-70
Herbicide	II-81
Manual	II-76
Mechanical	II-78
Prescribed Burning	II-73
The NEPA Process	I-14; I-16
Noxious Weeds	III-30; IV-60
Public Participation	I-8; II-28; Appendix I
Rangeland	III-28; IV-59; Appendix F
Recreation	III-40; IV-77
Rights-Of-Way	III-42; IV-78
Riparian Resources	III-29; IV-71
Scenery	III-44; IV-81
Scope	I-5

Short-Term vs. Long-Term Productivity	IV-133
Smoke	II-27; III-11; IV-31
Social and Economic Effects	I-9; II-29; III-48; IV-129; Appendix B
Soils	III-6; IV-13
Threatened, Endangered and Sensitive Species	
Animals	III-36; IV-71
Plants	III-33; IV-62
Timber Yields	II-25; IV-51; Appendices A, E
Unavoidable Adverse Effects	IV-134
Vegetation Management Methods	II-63; Appendix G
Biological	II-67
Herbicide	II-78
Manual	II-75
Prescribed Burning	II-70
Vegetation Subregions	III-22
Water	III-20; IV-41
Wildlife and Wildlife Habitat	III-34; IV-63



R0001 182708



R0001 182708